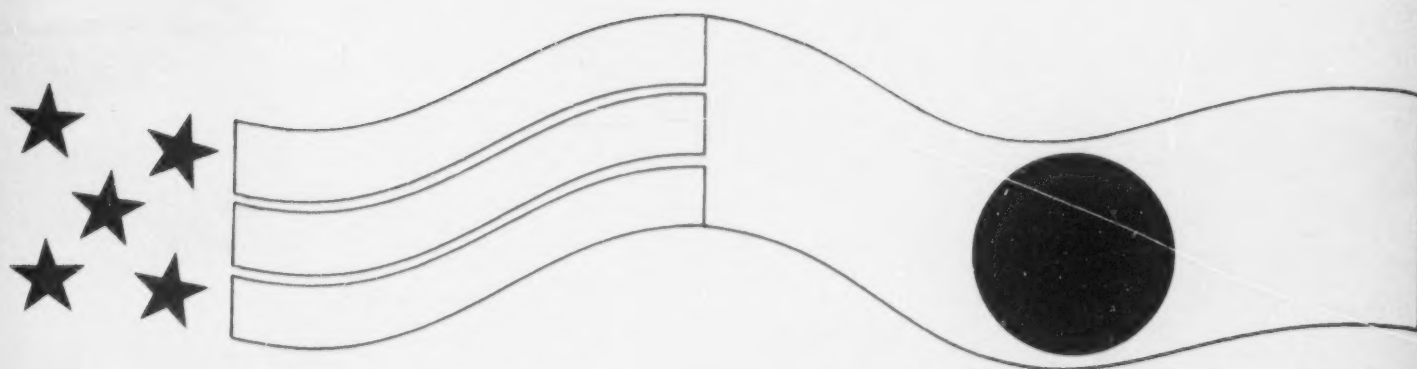


Comparative Productivity Dynamics

Japan and the United States



Total Factor, Labor and
Capital Productivity Levels
and Trends in the Decade
of the Seventies

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Houston, Texas

November, 1982

EXECUTIVE SUMMARY

History teaches that nations rise and fall in economic power and world leadership.

Just as the United States succeeded the United Kingdom during World War II in dominance of industrial output, world trade and productivity, so now Japan, the "weakling" of the major industrial powers at the close of World War II, appears well on the way to succeeding the United States in world trade dominance and in levels of productivity -- by or perhaps even before the turn of the century.

This new American Productivity Center multiple-input productivity comparison for the U.S. and Japan, providing an in-depth insight into current productivity dynamics and the factors governing them, reveals that at the close of the economically-troubled decade of the '70s Japan's output per hour for the manufacturing sector -- the most important of all segments of the economy in relation to the export market -- already had reached a level of 80 percent that of the United States. And despite recessionary pressures its output per hour continued to improve more rapidly than that of U.S. manufacturing.

For manufacturing industries of particular importance in world trade -- primary metals, chemicals, machinery and transportation equipment -- Japanese producers in 1980 were either far above their U.S. counterparts or approximately matching them. Our data show Japanese producers at productivity levels 180 percent of their U.S. counterparts in primary metals and 130 percent of the U.S. in electrical machinery manufacturing. Japan Productivity Center data just published also indicate startling productivity advantages for general machinery, precision instruments and transportation equipment other than automobiles.

Another fact of outstanding economic importance which emerges clearly from the array of data provided in the Center's productivity comparison is the pervading divergences in both levels and trends of productivity which underlie the averages for the total economy. The study shows that these divergences -- while very large for the United States -- are much greater for the Japanese economy. Sectors of the Japanese business economy which were particularly damaging to her average productivity level were agriculture (in 1980, only one-third that of the U.S.); construction (only one-half the U.S. level) and trade (just over half of the U.S.). These markedly weak sectors have offset the spectacular Japanese gains in productivity in more-favored industries.

Hence, despite Japan's tremendously-rapid productivity gains in manufacturing and some other segments of the economy, output per hour for the total economy at the close of the decade of the '70s was only a bit more than half that of the United States; and for private business, just under two-thirds that of the U.S. However, it is worth emphasizing that for the sectors which contribute most to export trade and national income from overseas, Japan's development has been and continues very strong.

Total factor productivity (TFP) rose between 1970 and 1980 an average of 0.6 percent per year for U.S. private business; and 2.3 percent per year for Japan. Growth rates for individual sectors of the U.S. economy ranged from a 1.7 percent per year for manufacturing and 2.8 percent per year for the combined transportation/communications industries down to -2.5 percent per year for mining and -2.3 percent per year for construction. For Japan, TFP growth ranged from 4.6 percent per year for mining and 4.4 percent per year for finance and insurance, down to losses of 5.0 percent per year for agriculture; 2.6 percent per year for the business, professional and other services sector, and -1.4 percent per year for construction.

While all but one U.S. manufacturing industry group (primary metals) recorded some TFP gain in the decade of the '70s, electrical machinery's modest 3.3 percent per year was the highest. For Japanese manufacturing, all industry groups showed good to strong productivity growth, ranging up to 14.2 percent per year for the electrical machinery group, with large gains also for chemicals, primary metals, transportation equipment and textiles.

In general, labor productivity growth rates for both sectors and industries in both the U.S. and Japan were more favorable than for total factor productivity. (This is to be expected since increase in technology embodied in capital input is among the factors driving increases in labor productivity.) For the private business economies, labor productivity in Japan rose at a 5.3 percent per year clip, roughly two and a half times the U.S. pace.

Individual Japanese growth rates were significantly higher than their U.S. counterparts in all sectors and manufacturing industries except the transportation/communications aggregate, where U.S. productivity growth roughly matched that of Japan.

Growth rates for individual sectors for Japan ranged up to 8.7 percent per year for mining. For manufacturing industries, extreme highs of 17.9 percent per year for electrical machinery, 10.5 percent for chemicals and 9.5 percent per year for primary metals were recorded.

For the key steel industry, BLS data show Japan's steel makers performing at levels of output per hour up to 155 percent of U.S. in 1980. Comparable data for productivity, hourly labor cost and the resultant unit labor cost for steel making are:

Japan as a percent of U.S. level, 1980

	<u>Minimum</u>	<u>Maximum</u>
Output per hour	128%	155%
Hourly labor cost	52%	53%
Unit labor cost	34%	41%

The Japanese advantage in current levels of productivity in steel-making is the direct result of the tremendous differences in technology in U.S. and Japanese steel industries. Very revealing are the following highlights:

- o Japan continues to top the world in the number of the highly efficient very large basic oxygen furnaces and continuous casters

-- 39 huge b. o. f. Japanese installations compared to only seven in the U.S.

- o Japan's steel industry has cut its dependence on oil in half since 1973; and achieved a total reduction in energy consumption of 16 percent -- an average increase in energy productivity of 1.5 percent per year -- sharp contrast to the U.S. steel industry's estimated decline in energy productivity of 1.5 percent per year.

Many factors have contributed to Japan's rapid post-war productivity growth and the extremely high present levels of productivity within some industries. Because they can be readily quantified, the influence of some factors is more readily apparent. For example:

- o A rate of personal savings averaging four times the US level, which makes possible the financing of gross fixed capital formation at an average ratio exceeding 30 percent of gross national product -- roughly double the U.S. rate.
- o Growth of real output during the post World War II years averaging over eight percent per year compared to 3.4 percent per year for the U.S. national economy. The Japanese growth advantage for the private business economy (5.5 percent per year) has carried over despite the vicissitudes of the 1970s. This compares to the U.S. rate of 3.1 percent per year for the decade.
- o Impetus for continuing technological improvement, an accelerated "learning curve" for both management and worker cadres and a high average level of plant capacity utilization -- all factors which can be seen as by-products of rapid output growth.
- o A vigorous growth stimulating program, focused on increasing exports, carried out by the Japanese government following the Occupation. Individual high export-potential industries were given preferential developmental assistance by the government while non-targeted sectors were more or less ignored. This influence contributed directly not only to productivity growth rates achieved by some sectors and industries but also to the increasing divergence in productivity levels and trends among the Japanese sectors and industries.
- o Careful attention to improving research, development and the rapid dissemination and use of new technology.

A number of other factors, though more difficult to quantify, are recognized as central to Japan's phenomenal growth. Among these are:

- o The close cooperation that exists among labor, management, academia and government. Central to this is a belief that productivity improvement should be the responsibility of both labor and management -- that workers have an obligation to improve quality and efficiency and that the company must be committed to offering life long employment and retraining as necessary to sustain such improvements.

- o A cultural dedication to achieving consensus around a superordinate goal and to adapting to change as necessary to concentrate on "what works."

COMPARATIVE PRODUCTIVITY DYNAMICS:
JAPAN AND THE UNITED STATES
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PREFACE

During virtually all of the first eight decades of the twentieth century, the U.S. was the unchallenged world leader -- in output, world trade, productivity, management, science/technology, and in the standard of living of its people. However, our leadership in all of these areas has eroded during the past 15 years. This new trend is due to significant slow-downs in our own growth, coupled with extremely-rapid post World War II gains by major competitors in the international marketplace -- with Japan leading all major industrial nations in growth rates of productivity, national output, exports to world markets and in real earnings of its workers.

A recent issue of the Japan Economic Journal predicted, on the basis of a new report by the prestigious Japanese Economic Council, that by the beginning of the twenty-first century Japan's output per capita would match that of the United States. Data compiled by the American Productivity Center tend to support this prediction, with estimated national real output per employee for Japan exceeding that of the U.S. by the year 2000, though output per hour would still be somewhat below the anticipated U.S. level.

Japan also will match or exceed U.S. performance in productivity and in world export for many major industrial products, including steel, automobiles, motorcycles large and small household electrical appliances, clocks, calculators, audio-visual equipment and electronic devices.

Hence, it is most appropriate that this new -- and first in-depth -- Japan/U.S. comparison of national and industry multiple-input productivity appear at this time. There has been an increasing demand for international productivity comparisons delving below the level of the national total, and showing levels and trends in terms other than labor productivity per se, which in some circumstances can be a misleading indicator for policy decisions.

This new data series presents early post-war labor productivity trends for the domestic economy, for the major sectors and for the manufacturing industries. For the decade of the '70s, it provides not only labor productivity data, but also "total factor" and capital productivity growth rates, and trends in the capital/labor ratio -- a series of particular economic interest for the post-OPEC span of 1973-80. I commend the series to you highly.

The American Productivity Center's future work plan calls for the eventual shaping of similar in-depth multiple-input comparisons for other countries with the collaboration and support of key OECD-member actions. These comparisons, when available to complement our new Japan/U.S. study, will provide leaders of industry, government planners and academic researchers invaluable new tools for study and action.

Special acknowledgment and gratitude are due to the Alfred P. Sloan Foundation for the funding it provides to production of the Center's multiple

input productivity index from which much of the United States capital and total factor data for this study were derived.

I wish to express my personal thanks to Chairman Kohei Goshi, to Dr. Sasaki, and to the other members of the staff of Japan Productivity Center Tokyo, as well as to the Director of the U.S. Office of the Japan Productivity Center, Mr. Joji Arai, for their collaboration with the American Productivity Center in providing the Japanese statistics essential for this effort. The Center welcomes similar collaboration from the relevant officials of other OECD-member nations.

C. Jackson Grayson, Jr.
Chairman
American Productivity Center

INTRODUCTION

This Japan/U.S. multiple-input productivity comparison has been generated by the American Productivity Center not only to provide current analysis for the two nations directly covered, but also to serve as a prototype for similar comparisons of other major industrial nations which we hope to see produced in due course.

The comparison presented in this document fills a significant void in the current international productivity literature, in that it:

- o covers a number of years, with a terminal year of 1980, the most as recent year for which data are available;
- o provides productivity data on both nations not only for the entire domestic economy and for private business, but also for the principal sectors of the economy and for major manufacturing industry groups and key industries;
- o breaks with the earlier limitation of international comparisons to labor productivity only -- a productivity measure which increasingly appears to be inherently misleading in the post-OPEC years, since it ignores the impact of increases or declines in prices and inputs of energy and capital, and the reality of capital/labor trade-offs. This new American Productivity Center/Japan Productivity Center comparison provides comparable data for the decade of the '70s in terms of total factor, labor and capital productivity, plus the economically significant capital/ labor ratio; and
- o provides in context a significant amount of specific analytical material to meet a frequently-expressed need, which Mr. Peter Weitz, Director of Programs for the German Marshall Fund of the United States, underscored in recent correspondence with the Center: "I find some of the popular discussions of productivity growth trends which I see of only limited utility. There is very little attempt to explain variants, or even to suggest what variables may explain variance. I wonder if you are familiar with any comparative work which both disaggregates to industry and even inter-firm comparisons, on the one hand, and which uses sufficiently comprehensive data to provide some policy-useful explanation for differential growth rates".

The most recent international comparison work by John Kendrick, which we quote a number of times in the text which follows, made a giant stride toward correcting the deficiency in interpretation of factors shaping differential productivity trends. His paper provides a wealth of useful analysis of factors determining the international variations in productivity trends for the private business economies. However, Dr. Kendrick's comparisons still only skim the surface of international productivity dynamics, since he does not attempt to delve below the level of the total private business economies.

In order to provide useful historical perspective and to meet the observed needs as fully as possible in this first in-depth multiple-input productivity comparison, we have drawn on a variety of data and information sources, in addition to the new APC/JPC multiple-input data series covering the decade 1970-80. Material is presented for a longer time span for the domestic economies of the two nations, with data relating their experience to that of other major industrial nations. In addition, in-depth comparisons are presented for the private business economies, for the major sectors and for manufacturing industry in terms of labor productivity trends for the two-decade span 1950-70. This material (which leads in to the more comprehensive multiple-input series generated by the American Productivity Center, with input from JPC) was shaped by the authors from a number of different sources, as credited at the point of citation on the text and also included in the list of sources and recommended readings.

A summary statement of sources for data and methodology for the APC/JPC multiple-input comparison is presented in Appendix 1. We have attempted to phrase this information in non-technical language, for ready comprehension by the average businessman and other interested persons not well-grounded in statistical methodology.

We emphasize that the methodology applied is that developed by John Kendrick in his approach to total factor measures of productivity, as published in several books, the most recent of which was "Productivity in the United States: Trends and Cycles," The Johns Hopkins University Press (Baltimore and London, 1980) jointly authored by Kendrick and Elliot S. Grossman -- who is also joint author of this new APC Japan-U.S. comparison.

As stated by Center Chairman Grayson in the Preface to this report, the American Productivity Center hopes that other major industrial nations decide to collaborate with the Center in shaping multiple-input comparisons which are comparable in basic methodology. We understand that the Japan Productivity Center shares this hope with the American Productivity Center, since a series of such comparisons would provide businessmen and national policy makers a wealth of information which is not now available.

We have good reason to believe that many of the major industrialized nations, especially OECD members, should have most if not all of the basic data required to shape such comparisons, for at least the private business economy, the major sectors and the more important individual manufacturing industries or industry groups. As partial evidence, we emphasize that John Kendrick computed, primarily from data provided by the OECD, series of multiple-input productivity comparisons for the time spans 1960-73 and 1973-79 which cover the total domestic economy and the private business economy.

It does not appear unduly optimistic to assume that comparable data for sectors and key manufacturing industries either are already available or could be compiled by major OECD-member nations, by IISEAD, or by the OECD itself to match at least in part the scope of the present Japan/U.S. comparison.

The American Productivity Center would welcome any overtures along these lines.

COMPARATIVE PRODUCTIVITY DYNAMICS:
JAPAN AND THE UNITED STATES

Chapter I.

Overview and Historical Perspective: Long-term Trends in Output and Labor Productivity.

A. The First Two Post-WWII Decades

Over the first three-quarters of the twentieth century (with the exception of a slippage in the disastrous years of the Great Depression of the '30s) real output of the United States economy grew steadily along with the standard of living of its growing population. The continuing rise in output, despite significant decreases in hours worked per employee, was traceable directly to comparatively strong and continuing increases in labor productivity (output per employee and output per hour).

By mid-century, U.S. productivity, national output and volume of world trade towered over any of its competitors in the industrial world marketplace. In 1950, U.S. real national output per hour was roughly double that of any of the leading Western European nations; far above that of Canada; and at least seven times that of Japan.¹

During the next two decades, which have been identified as "the golden era of productivity", U.S. productivity rose at a pace even more rapid than in any past periods, as wartime technological developments were adapted for civilian output, and the pent-up demand for civilian products assured a continuing strong market for consumer goods of all types.

However, during the same period the war-ravaged nations of Western Europe and Japan forged ahead even more rapidly -- in national output, in export market volume and in industrial productivity growth. Their success in recovery stemmed from a combination of factors. They made dedicated national efforts to rebuild their shattered industries, supported by substantial national savings by the citizens, which made possible capital investments ranging upward from 20 percent of current national product -- more than double the U.S. pace.

These efforts were supported by a large international transfer of U.S. development funding, management know-how, technology embodied in patents, product design, and high-efficiency machinery and equipment.

¹ Data provided by Dr. Angus Maddison, in "Phases of Capitalist Development", Oxford University Press (London & New York) 1982, show real GDP per hour in 1950 at the following percentages: Japan, 14; France, 44; W. Germany, 33; the United Kingdom, 56; Italy, 32; Canada, 78.

Their dedicated attention to the export market led to their capture of an increasing share of world trade, rapidly undercutting the tremendous trade advantage held by the U.S. in the early post-war years.

As a result, productivity leaped upward in these nations in the '50s and '60s at a pace several times that of earlier years and far in excess of the U.S. productivity growth rates. The manufacturing sector, focusing heavily on the export market, made the largest contribution to these post-war gains in productivity. Hence, despite reasonably strong post-war productivity gains, the U.S. in the '50s and '60s began to fall farther and farther behind the growth rate of its major competitors in the world marketplace. (Table 1 and Appendix III, Table 3).

For Japan, the relatively-modest long-term growth rate in real output and productivity during the first half of the 20th Century had been wiped out by the devastation of World War II. In the early stages of its industrial recovery (1950) Japan's level of real domestic output per hour was only about 14 percent that of the United States, as compared to a level of 33 percent that of the United States which Japan reached in 1938.

During the '50s and '60s, however, Japan exceeded all other nations in rebuilding its industrial community, with a single-minded focus on applying maximum proportions of its national income to the shaping of new industries and product marketing services targeting the international marketplace. The Japanese nation demonstrated an unique capability to absorb from other nations and adapt to its own use "best practice" technology, product design and managerial concepts.

Working in close cooperation, Japanese labor, management and government focused their post-war industrial development and international marketing activity on intense efforts to improve quality of product to the maximum degree, coupled with vigorous efforts to design products attractive to overseas purchasers. Accompanying the 1950-60 drive to improve inherent design quality of its products (partly to overcome the earlier reputation for shoddy Japanese products) was an unique concentration on the assurance of high quality of workmanship in the fabrication/assembly stage for manufactured goods, pegged to a "zero-defect" production standard.

The improvement in product design and quality control in production were accompanied by increasing efforts to eliminate waste -- of both materials and lost labor time due to rejects -- which in due course contributed strongly to measured gains in output of product per unit of material input and per hour of labor input.

In this context though it has become more fully understood only in the past few years, Japan was the first and probably is still the best example of the "productivity/quality connection" which has become increasingly accepted in the industrial world as the key to strong bottom-line profitability and strong growth.

In the past two or three years, for the first time in the post-World War II period, U.S. industrialists and other national leaders are devoting major attention to studying the Japanese approach to integrating built-in control of product quality with a planned materials and labor-saving production structuring. (The materials and parts inventory control method used in

Table 1.
Post-War Labor Productivity Dynamics, U.S. and Japan: Selected Periods, 1950-81
(For the domestic economy; private business; and manufacturing)

1. Trends in Output per Hour

Segment of the economy	Average annual rate of growth							
	1950-60		1960-73		1973-80		1980-81	
	U.S.	Japan	U.S.	Japan	U.S.	Japan	U.S.	Japan
Domestic Economy ¹	2.4	5.7	2.6	9.8	1.2	3.8	1.0P	3.0P
Pvt. Bus. Economy ²	2.6	6.0	2.9	9.9	0.4	3.8	1.1	3.5P
Mfg. Industry ²	2.0	9.3	3.4	10.5	1.3	6.6	2.2	2.5P ³

2. Levels of Output per Hour

Segment of the economy	Estimated levels of real output per hour (in U.S. constant \$)							
	1870	1900	1938	1950	1960	1970	1973	1980
Domestic Economy ¹								
U.S.	0.70	1.29	2.62	4.25	5.41	6.96	7.50	8.33
Japan	0.17	n.a.	0.87	0.59	1.03	2.70	3.49	4.53
Private Business ²								
U.S.	--	--	--	--	--	8.27	9.06	9.27
Japan	--	--	--	--	--	3.59	9.06	9.27
Manufacturing ²								
U.S.	--	--	--	--	--	7.92	9.30	10.17
Japan	--	--	--	--	--	3.91	5.12	8.00

¹ Productivity expressed in terms of real domestic product per hour, at 1970 market prices, in U.S. \$ equivalents.

² Productivity expressed in terms of real value added per hour, at 1975 market prices, for the private business economy and for manufacturing. (The effect of inflation between 1970 and 1975 causes value expressed in 1975 dollars to be higher than those expressed in 1970 dollars. The two levels are used here since 1970 constant-dollar levels are not available for manufacturing and other segments of the business economy.

³ BLS shows an estimated 80-81 growth rate for Japan of 2.9%. Japan Productivity Center reports 3.5% increase.

Source: American Productivity Center

Basic data: Private business and manufacturing, APC's binary U.S./Japan comparison. Domestic economy, over the long time span. Angus Maddison's "Phases of Capitalist Development," Oxford U. Press, 1982.

Japanese line production of automobiles, for example (in Japanese, "kan-ban", or "just in time") is now accepted by an increasing number of U.S. and European automobile manufacturers as an ideal, but difficult to apply because of the geographical dispersion of parts and components suppliers, most of whom are far away from the assembly plants.

As a direct result of such well-organized efforts, the real national output of Japan and her share in the world market grew with extreme rapidity in the 1950's and '60s, driven by gains in productivity at a rate unrivaled in world history. Real output per hour for the domestic economy rose almost 6 percent per year during the decade of the '50s and nearly 10 percent per year during the '60s. For manufacturing industry, labor productivity grew over 9 percent per year during the '50s and over 10 percent per year during the '60s -- far beyond the pace of even the best of the European economies, and more than three times the rate for the United States manufacturing community.

Three points stand out markedly in the relative trends of labor productivity for the United States and Japan during the '50s and '60s:

1. Japan's growth-rate advantage applied for the total domestic economy; for all private business; and for the manufacturing sector, in both decades;
2. The Japanese productivity advantage was in all instances much greater during the '60s than in the '50s, due to a greater acceleration of growth rates, as the rate of output growth escalated and increasingly-efficient techniques were applied; and
3. By far the largest Japanese differential was in the manufacturing sector. Trends for agriculture, retail trade and the services industries reflect a relative advantage for the United States.

B. The OPEC Oil Shock; Recession; and Productivity Catastrophe:

The golden sheen of the most rapid productivity growth rates in all the industrial nations which the world had ever seen was rapidly tarnished by the OPEC oil shock of 1973. The October 1973 embargo on petroleum sales and the subsequent quantum leaps in prices (four-fold in 1973-74; and an additional four-fold in 1979 and 1980) ended a century-long period of increasing use of cheap energy-driven machinery and equipment to replace labor input.

The world-wide efforts during the mid and late 1970s for the conservation of energy, including mandated cutbacks in the use of petroleum products, forcibly retired a significant percentage of the industrial world's machinery and equipment. They forced changes in methods of production; work-flow in the plants; and distribution of products. The escalation of equipment prices and interest rates, coupled with uncertainties concerning Government regulations on energy usage, forced the postponement of a large volume of planned plant modernization, while managers awaited the development of a new generation of more energy-efficient machinery and equipment. Present indications are that these developments have permanently reduced the future percentage of petroleum products in the world's total energy use pattern.

In the wake of the oil price escalations, already-strong inflationary tendencies and increasingly severe international currency-exchange problems escalated dramatically. Hence, the industrial world plunged into major recession in 1974-75. After a hesitant -- and limited -- recovery in 1976-79, the industrial nations staggered together into a second -- and generally even more devastating -- "double-dip" recession in 1980-81 -- from which they have not yet recovered.

For the U.S. economy, the result was a slowdown of the growth in real output of the private business economy in 1973-80 to a pace only a little over 2 percent per year -- not much more than half the growth rates of 3.5 percent to 4 percent per year in past decades. Inflation rose to double-digit levels, previously unheard of in the U.S. economy in peace-time. The labor productivity growth for the U.S. private business economy fell during the post-OPEC span to an average of only 1.3 percent per year during 1973-77.

Output per hour then actually declined slightly but steadily three years in a row, at the average rate of almost 0.3 percent per year. Never before in U.S. history had this occurred. Only in calendar 1981 was the decline arrested by a small (1.1 percent) increase. (Table 1).

During the seven-year span following the first OPEC price shock, though her economy was more dependent upon imported oil than almost any other major industrial nation, Japan coped more successfully than did the U.S. in the adjustment to higher-priced and quantity-controlled petroleum products, and successfully developed new markets for her expanding output of high quality products. As a result, real output for the national economy grew at an annual rate of 3.7 percent per year during 1973-80, as compared to the U.S. pace of only 2.3 percent per year; and labor productivity for the economy rose 3.8 percent per year, in sharp contrast to the U.S. pace of only 1.2 percent per year.

The competitive advantage accruing to the Japanese economy during the post OPEC-shock years due to its rapid labor productivity growth was even more marked in the private business segment: a rate of 3.8 percent/year for Japan, but less than 1/2 of 1 percent per year for the U.S.

The end result of the divergent national productivity growth patterns of Japan and the U.S. during the post-war span is that the truly-tremendous gap in labor productivity in 1950 (Japan at an estimated level of only 14% that of the U.S.) had been cut down dramatically. The estimated relative levels of real gross domestic product per hour for the two nations in 1981 show Japan at a level of 54 percent that of the U.S. However, due to the far higher average hours per employee year worked in Japan, her national level of output per employee has reached 70 percent that of the U.S. in 1981.

Knowledgeable observers predict that by the turn of the century, Japan's real national productivity level (not just the growth rate) will be the highest in the industrial world -- significantly above the U.S., and far above all the European nations with the possible exception of Germany and France.

Table 2. Output, Inputs and Productivity
Growth Rates, U.S. and Japan, 1970 to 1980.

AVERAGE ANNUAL PERCENT OF CHANGE

Segment of Economy	<u>Outputs and Inputs</u>						<u>Productivity Ratios</u>					
	<u>Output</u>		<u>Labor Input</u>		<u>Capital Input</u>		<u>Total Factor Productivity</u>		<u>Output per Unit of Labor</u>		<u>Capital/Labor Ratio</u>	
	<u>U.S.</u>	<u>Japan</u>	<u>U.S.</u>	<u>Japan</u>	<u>U.S.</u>	<u>Japan</u>	<u>U.S.</u>	<u>Japan</u>	<u>U.S.</u>	<u>Japan</u>	<u>U.S.</u>	<u>Japan</u>
Private Domestic Business	3.1	5.5	1.9	0.2	3.6	8.5	0.6	2.3	1.2	5.3	1.7	8.3
Agriculture	1.6	0.2	0.0	-5.2	3.5	9.0	-1.2	-5.0	1.6	5.7	3.5	14.9
NonFarm Manufacturing	3.3	5.1	2.6	1.9	3.7	9.2	0.2	0.6	0.6	3.2	1.0	7.2
Mining	1.5	2.5	5.3	-5.7	3.0	2.5	-2.5	4.6	-3.5	8.7	-2.1	8.8
Construction	0.2	3.4	2.6	2.7	2.1	12.0	-2.3	-1.4	-2.4	0.7	-0.5	9.1
Transportation & Comm.	4.7	5.0	1.1	1.0	3.4	7.0	2.8	3.2	3.5	3.9	2.3	5.9
Electricity, Gas & Water	3.2	4.5	1.7	1.0	5.1	8.3	-0.5	0.1	1.4	3.5	3.4	7.3
Trade	3.3	5.6	1.8	0.9	4.4	9.6	0.8	2.3	1.4	4.6	2.5	8.7
Finance and Insurance	3.4	8.1	3.4	2.0	9.5	6.4	-0.5	4.4	0.0	6.0	5.8	4.4
Real Estate	3.5	7.1	4.5	5.9	2.1	9.4	1.2	-1.9	-1.0	1.1	-2.3	3.3
Business Services	3.8	3.5	3.9	2.9	3.8	13.3	-0.1	-2.6	-0.1	0.6	-0.1	10.1
Manufacturing	3.0	7.1	0.5	-0.4	3.4	7.7	1.7	4.9	2.5	7.4	2.9	8.1
Food & Tobacco	2.7	5.1	-0.7	-1.2	1.9	8.1	2.7	2.4	3.5	6.4	2.6	9.4
Textiles	2.1	3.2	-1.2	-3.0	1.3	3.8	2.7	4.4	3.3	6.4	2.5	7.0
Pulp & Paper	2.9	4.2	-0.1	-1.8	3.7	7.9	1.9	2.3	3.0	6.0	3.7	9.8
Chemicals	4.4	9.2	0.5	-1.2	4.0	6.3	2.5	6.8	3.8	10.5	3.4	7.6
Primary Metals	-0.6	7.8	-1.0	-1.6	1.7	7.3	-0.2	5.0	0.4	9.5	2.8	9.0
Fabricated Metals	1.9	3.2	0.3	-0.4	4.2	10.5	0.9	2.5	1.7	3.6	3.9	10.9
Machinery exc. Elec.	4.0	6.3	2.3	-0.7	5.2	7.3	1.0	5.8	1.6	7.1	2.8	8.1
Electrical Machinery	5.3	17.7	1.2	0.6	4.4	7.8	3.3	14.2	4.0	17.0	3.1	7.2
Transportation Equip.	2.8	8.5	0.2	1.4	4.4	8.6	1.5	4.8	2.6	7.1	4.2	7.1
Other Manufacturing*	2.9	3.6	0.6	0.6	3.6	8.8	1.3	1.1	2.3	3.0	3.0	8.1

** Includes Apparel; Lumber; Furniture; Printing & Publishing; Petroleum; Stone; Clay, Stone & Glass; Leather; Instruments; and Miscellaneous Manufacturing.

Source: American Productivity Center

C. Labor Productivity Trends in Individual Manufacturing Industries, 1960-1973

Reliable multiple-input productivity series are not presently available for Japan for years prior to 1970 for the major sectors and manufacturing industries. However, we have used data from APC's own publications, plus Japan Productivity Center and U.S. Bureau of Labor Statistics industry productivity indexes to compute a reasonably reliable labor productivity series for the span 1960-73 for most of the manufacturing industry groups.

By historical standards most U.S. manufacturing industries tracked in this comparison recorded reasonable increases in productivity in the 60's ranging up to 5.3 percent per year for textiles and chemicals. However, their growth pattern was very dim indeed in comparison to the rates recorded by three-fifths of the Japanese industries, which rose at unheard of percentages: 13.4 percent per year for chemicals; and 12 percent per year or over for primary metals, electrical machinery, transportation equipment and the combined "other industries" amalgam. Even Japan's "poorest performers" were above the U.S. rates for the same groups, except for textiles. The key steel and motor vehicles industries (components of the primary metals and transportation equipment groups) rose at over 11 percent per year -- more than triple the U.S. rate of increase for the same industries. (Figure 1)

Also depressing from the U.S. industrialists' viewpoint is the fact that U.S. manufacturing output per hour growth rates for this span were below those of Canada and all of the Western European nations, including the United Kingdom (Figure 2).

While we lack specific and detailed information on the combination of factors affecting comparative trends in the sixties for each of the individual industry groups, a number of facts are clear. Major influences which led to both inter-group differences within each nation and to the larger inter-country differences included:

- o Relative age and condition of machinery and equipment;
- o The pace of technological innovation, which was substantial for chemicals and textiles in the U.S.; and very rapid indeed in Japan for transportation equipment (shipbuilding; autos and trucks; aircraft engines and parts); electrical, photographic and communications equipment; calculators, computers, and other items such as precision instruments, audio-visual equipment, and watches.
- o Differences in output growth rates and in utilization of existing plant capacity -- a key short-term productivity determinant -- due both to purely domestic influences and to increasing success in the international marketplace.

In the case of Japan, it is certain that there is a direct relationship between the productivity growth rate advantage for several of the industries and the success of Government efforts which targeted them for development and

export marketing growth. The Japanese industrial development program targeted in the 1950's steel, motorcycles, audio equipment, watches, instruments, automobiles and small electrical appliances.

In the 1960's, this support focused on automobiles, shipbuilding and steel; and continued for electric appliances and photographic and communications equipment designed primarily for the export market.

Later, in the 1970's, the primary focus of the Government's industrial strengthening activity was on semi-conductors and other electronic equipment; computers; aircraft engines and specialty components; and other high-technology items, chiefly robotics; instruments and advanced information technology and communications products. (Additional detail on this point is offered in Chapters II and III.)

The importance to productivity growth of the Government's successive targeting for development of key industries such as those listed above is both direct and obvious:

- o Preferential attention in financing for R&D and on assuring rapid diffusion of innovation leads directly to higher technology and improved production efficiency;
- o The accompanying preferential financial arrangements for both purchase and installation of improved equipment and the import of materials and components on favorable credit terms, plus aid in marketing the products overseas, leads to an improved capital/labor ratio, rising output volume and favorable cost/profit margins, permitting strongly-competitive pricing of the favored product lines.
- o The resulting increases in output volume and sales leads directly to a high level of capacity utilization, which is in itself a major short-term contributor to high productivity.

Chapter II.

Multiple Input Productivity Dynamics in the Seventies, by Sector and Industry

In this Chapter, we will present and analyze levels and trends of total factor, labor and capital productivity for the sectors and industries which underly the pattern for the total private business economy. This is new detail in international productivity comparisons, since past series have been limited to either the totals for the domestic economy, the private business economy, or at most analyses of trends in labor productivity for agriculture, industry and the services.

After covering the general picture for the private business economy, we present data for the aggregated goods-producing and services-generating industries. We then follow with brief analyses and data for the non-manufacturing sectors. We conclude with a detailed presentation of productivity dynamics coupled with some of the factors determining them for the manufacturing sector and major individual industries.

A. The Private Business Economy

The dynamics of output, inputs and productivity in the U.S. and Japan during the 1970's show major differences in pattern, which in the aggregate were much more favorable for the health of the Japanese economy than for that of the United States:

OUTPUT during the decade grew at an annual rate of 5.5 percent per year for Japan, but only 3.1 percent per year for the U.S. Also, on the basis of information available as of mid-year 1982, it is evident that Japan's superior output growth rate has continued, though both nations have suffered through recessions in 1980-81 following the second oil price shock of 1979-80 -- with the economic doldrums persisting. The Goldman-Sachs "pocket chartroom" issuance for June/July 1982 provides estimates that real GNP for Japan will rise in 1982 at 2.8 percent, following a modest 2.7 percent rise in calendar 1981. A stronger increase of 3.5 percent is projected for 1983.¹

While these current output growth rates for the Japanese economy are significantly below the pace achieved for the 70's and earlier postwar decades, they are much stronger than the feeble performance of the U.S. economy, with an actual GNP growth of -0.3 percent in 1981, an estimated 1.0 percent for 1982; and not over 2.0 percent for 1983. (Table 2).

1 These rates are slightly lower than OECD estimates published in December 1981. We consider them more realistic, however, since 1981 data are actual, and 1982 is based on six months performance to date.

Capital input in the private business economy of Japan grew rapidly, at an average rate of 8.5 percent per year -- more than double that of the United States rate of 3.6 percent per year. Of course, capital input involves expenditures both for adding to total plant capacity and for improvements in equipment and methods -- the latter, particularly, serving as a direct stimulant to productivity. Hence, the comparison between the average rates of increase of total output and of total capital input should serve as a very rough indicator of the extent of technological improvement. For Japan, her capital input growth of 8.5 percent per year was more than 50 percent larger than output growth at 5.5 percent per year, reflecting her extremely rapid pace of new equipment and work methods introduction.

In sharp contrast, U.S. capital input per year rose in the decade only 3.4 percent per year, just 16 percent above the rate of growth in total output (3.0 percent per year). This represents a clear indication of the relatively slow average pace of U.S. introduction of new plant and techniques. Hence, it is no wonder that Japan's average age of plant and equipment in the latter years of the decade was only about half that of the U.S.

Labor Input: It was obvious that a strong average increase in labor input was the major contributor to the modest real output growth of the United States business economy. Labor input growth (1.9 percent per year) accounted for almost two thirds of U.S. real product growth -- productivity based on improved machinery and methods just over one-third.

For Japan, labor input rose only 0.2 percent per year. Hence, the increase in labor input accounted for only a miniscule one-third of one percent of real output growth.

These contrasting trends in labor and capital input resulted in an average annual rise of 8.3 percent per year in the capital/labor ratio for Japan, in sharp contrast to the poor U.S. pace of 1.6 percent per year. This points up clearly the direct effect of Japan's heavy continuing input of investment capital, with the resultant strong growth rate in labor productivity -- and also in total factor productivity during most of the years of the decade.

While the following subsections explore in some detail the short-term cyclical patterns of productivity for the sectors and manufacturing industry groups, certain significant generalities for the private business economy as a whole are worthy of particular note at this point, since they exerted some effect upon all segments of the economy, though to varying degrees:

1. For both the U.S. and Japan, productivity rose relatively well for the first three years of the decade, prior to the OPEC oil embargo and the price escalations which followed. However, Japan's total factor productivity growth rate was double that of the U.S. In labor productivity terms, both nation's rates were higher than for TFP; but Japan's pace was over three times that of the U.S., for reasons noted above.

2. During the troubled years following the energy crisis, both countries suffered severe productivity growth slowdowns -- as did all the

world's industrial nations. Japan, however, coped somewhat more successfully than did the U.S. and other nations. Hence, her average post-OPEC rate was higher: 1.1 percent per year TFP, versus a decline of 0.3 percent per year for the U.S. For labor productivity, the 1973-80 rates were 3.8 percent per year for Japan, and 1.2 percent per year for the U.S. private business economy.

3. The average trend for the post-OPEC period actually cloaks some significant shorter-term cycles, as both nations were severely impacted by the world-wide recession of 1974-75; scrambled to recover growth in output and productivity during 1976 through 1978; and suffered renewed recession and output collapse following the second oil price shock of 1979-80, with which the Japanese business community coped much more successfully than did that of the United States. For the private business economies in both nations, the shorter span cyclical rates of the 70's were:

	TFP growth rate		Output/hour rate	
	U.S.	Japan	U.S.	Japan
1970-73	2.6	5.2	3.2	8.9
1973-75	-2.0	-1.4	-0.1	2.7
1975-78	1.6	1.6	1.3	3.3
1978-80	-1.3	3.0	-0.5	5.6

A comprehension of the significance of the Japan/U.S. productivity growth rate divergence may be facilitated by translating trends into relative absolute levels of labor productivity at selected periods. For example, Japan -- which had been generating real output per hour for the domestic economy at levels estimated at 14 percent in 1950 and 19 percent in 1960, reached a level of 40 percent in 1970; 46 percent in 1973; and 55 percent in 1980.

Expressed in terms of the private business economy (for which comparative absolute level data had not been available previously) our binary comparison, using constant U.S. 1975 dollar equivalents, show the following comparative levels for the U.S. and Japan:

	Real (1975 \$) Output per Hour, Private Business in:				
	1970	1973	1975	1978	1980
U.S.	8.27	9.06	8.99	9.36	9.27
Japan	3.59	4.65	4.89	5.38	6.01
Percent, Japan to U.S.	43.4	51.3	54.4	58.0	64.8

Looking ahead, the evidence indicates that Japan's business community (possibly excluding agriculture, construction and trade) should in due course equal -- and probably exceed -- the average productivity level achieved by its American counterpart. (The levels of Japanese agricultural and retail trade productivity are very low, however; and there is serious question as to whether they can be raised significantly in the next decade.)

Thus, it is evident that Japan during the 70's reduced the U.S. labor productivity level advantage for the business economy by roughly one-half, with the ratio almost certain to reach two-thirds of the U.S. before mid-1980. Also, as we note in the next section (on manufacturing industry productivity) Japan has already exceeded U.S. productivity levels in three (or perhaps even four) key manufacturing industries.

It is virtually certain that Japan's output and productivity growth rates will continue to exceed those of the U.S. during the 1980's -- and perhaps beyond. However, it appears equally probable that the future differential in U.S. and Japanese productivity growth rates will narrow considerably, for a number of reasons, including:

- o Much of Japanese industry had by the 1980's reached a stage of maturity where the continuation of earlier post-WWII years extremely-rapid output and productivity growth rates could not be expected to continue. To the degree this proves to be true, average productivity growth for the total business economy will be less-rapid than in the past three decades.
- o While Japan has continued to cope better than most nations with problems of growing international competition from some of the newly-industrializing nations and in her adjustment to economic stress, such as recession and the oil price shocks and attendant energy problems of the 70's, her growth in output -- based primarily on international market share -- cannot be expected to continue at the same pace. Japan's domestic market is not large, especially with the propensity of the nation's peoples to save rather than to spend. There is ample evidence of growing resistance in the United States and European countries to past rapid Japanese inroads in their domestic markets for both producer goods (such as steel and machine tools) and consumer goods (especially big-ticket items such as automobiles and household electrical appliances). Also, production of basic materials and finished products is increasing in the world's "developing" nations. Hence, it is likely that their own products will displace in part their imports from Japan, which grew so rapidly during the 1970's.

Obviously, a slowdown in output growth and in utilization of industrial plant capacity would tend to stultify the rapid Japanese productivity growth which has characterized the post World War II decades.

- o The dilution of the average skill and experience of the U.S. labor force in the late 60's and in the 70's, due to the unprecedented rate of entry of women and younger men, is not expected by demographers to continue. Rather, it is anticipated that the average capability of the U.S. worker will be substantially higher in the 80's than in the 70's; and that the occupational pattern will involve an increasingly-high proportion of professionals and skilled technologists to handle the increased automation and computer-aided production operations anticipated for the goods-producing industries, plus the controls of more highly automated

technologies in the service industries. This should tend to increase both absolute levels and growth rates of U.S. labor productivity.

- o An additional factor which is as yet impossible to gauge accurately is the extent to which the United States business community will make intensified efforts to improve not only work methods and technology, but also the extent to which business, labor and the Federal Government learn to work together to improve productivity and export market growth. All observers agree that deficiencies in this area contributed significantly to the U.S. productivity slowdown and international market losses in the late 60's and the 70's.
- o In the area of technology, it is as yet too early to even attempt to guess the impact in both nations of new developments, such as the revolution in office technology; robotization in the factory; lasers; improved high capacity chips and other semiconductors; and major breakthroughs in communications technology, pegged to computerized control systems; and hydroponics and other breakthroughs in food production, to name only a few.

All of these areas are receiving substantial current attention in the U.S. and in Japan. It would take an unusually effective crystal ball to predict with any certainty which nation will gain the most from these or other new developments in its efforts to improve its productivity and standard of living. (However, the tremendous importance of each nation's relative progress in these areas of new high technology was emphasized in a new nationally-broadcast one hour TV special feature, "The high tech shoot out.")

One fact, however, does seem to us to be predictable: we are convinced that many of the new patterns of productivity growth, of world trade and of industrial production in the U.S., Japan, Western Europe and some of rapidly industrializing "third world" nations are, by and large, irreversable. We do not expect to see in the nineties and in the early years of the twenty-first century the continuation of the output patterns in the United States, Canada, Britain and some of the other major Western European nations which characterized the post-war span, through the seventies.

It seems inescapable that many of the major mature manufacturing industries in these nations (except for a hard core of "defense related" producers utilizing latest and best technology) will be phased out; and employment transferred to new high technology industries based on best practice which is now on the drawing board -- or not even as yet in the pilot stage.

Also, it seems probable that the U.S. economy of the near future will be even more service-oriented than at present, with an increasing proportion of its international -- as well as domestic -- business involved in the provision of services rather than goods. Such expansion is anticipated in the transportation, communications and information storage/retrieval/transfer services.

Also likely is a significant expansion in overseas sales of U.S. engineering, scientific and technical consulting and advisory services related particularly to new high technology production; to natural resources exploration and development and in hydroponics; and the shaping of new agricultural and other food production activity. Such activity may likely target not only the developing "third world" nations, but also many of the industrialized countries as well.

We believe it is entirely likely that any future expanded provision of leadership services of this type might well be carried out by international business consortia involving both the U.S. and Japan, to their mutual advantage.

B. Goods-producing and Services-producing Segments of the Economy

The data compiled for this binary productivity comparison provide useful new insights on the dynamics of productivity for the various segments and sectors of the two nations' business economies. A startling divergence in both absolute levels of labor productivity and in trends of total factor, labor and capital input/output relationships underlies the averages for the private business economies of both Nations.

This new information is expected to prove of significant value to both economic analysts and to business executives, since the more detailed information not only provides statistical evidence of level and trend patterns only guessed at before, but also helps to reveal some of the influences which have shaped both levels and trends in national productivity in the two nations. In Table 3 and in Figures 3 through 13, we are providing data and charted evidence of these productivity dynamics.

There has been a significant shift in relative output shares for the goods producing and the services generation segments of the U.S. and Japanese economies -- with Japan advancing slightly in the goods industries' share, and the U.S. moving rapidly towards a predominantly services producing economy: in 1980 services accounted for three-fifths of the U.S. total business output value. In sharp contrast, Japan's services industry segments held at a relatively constant level, with a drop in output share for the business and professional services sector partly offset by a rise of finance and insurance. At both the beginning and end of the decade, services accounted for just under 50 percent of the total for the Japanese private business economy.

An examination of labor productivity levels and growth rates over the decade for the two major segments of the two economies is truly revealing -- and reflects at least in part the result of the Japanese Government's primary focus on output efficiency in the export-generating goods industries, especially manufacturing and its supporting sector, the extractive industries.

As noted previously, Japan's business economy grew at an average annual rate of 5.3 percent per year in the 1970's, compared to the U.S. pace of only 1.5 percent. (Table 3) Underlying these average rates for total private business are the following significant dynamics:

	Output per Hour (U.S. 1975 \$)				Growth Rate, Average Annual O/Hour	
	1970		1980		1970-80	
	\$ U.S.	\$ Japan	\$ U.S.	\$ Japan	U.S.	Japan
Goods industry	8.37	3.14	9.68	5.99	1.5	6.7
Services	8.18	4.20	9.00	6.03	1.0	3.7

From the above, it can be seen that Japanese goods industry productivity rose almost twice as rapidly as did that of its services generating community, despite a rapid growth in efficiency in its important finance and insurance sector.

Labor productivity for the Japanese goods industries also grew on the average 4 1/2 times as rapidly as did that of their U.S. counterpart -- 6.7 percent versus 1.5 percent per year.

In the U.S., while productivity for the services segment did not rise as fast as that of the goods industries, the growth rate disadvantage was only one-third, as contrasted to a differential of nearly two to one for Japanese.

As we explain in more detail in Chapter III, Japanese Government preferential targeting of some of the strong export generating industries, with no comparable assistance to domestic service industries, made a very direct and large impact upon relative rates of growth in output and in productivity for designated industries. This serves to explain, at least to a considerable degree, the large difference in productivity growth rates between the two segments of the economy.

C. Productivity Dynamics for Sectors

1. Non-manufacturing Industry

Despite the overriding importance of the output and productivity growth performance of the Japanese manufacturing sector, it is far from the entire output and productivity story for the Japanese national economy in context of both prospects and problems. As is clear in the data presented in Table 3 and in Appendix 2 Tables 1 and 2, showing annual levels of labor productivity for the seventies, four of the major sectors of the Japanese economy fall in the "problem" category in terms of their productivity performance. The problems are apparently due in part to the physical or environmental limitations of the Japanese archipelago; in part to the retention of archaic operational mores and methods; and undoubtedly also in part to the noted preferential government treatment for key export oriented manufacturing industries.

The dismal productivity records of these four sectors are primarily responsible for the fact that Japan in 1980 is still significantly below the U.S., Germany, France, Belgium, the Netherlands, Italy and even the United Kingdom in real gross domestic product per hour worked. For private business and for these four sectors, Japan's 1980 level of output per hour was:

Output per Hour in 1980
Real (1975 constant U.S. \$)

<u>Private Business</u>	<u>\$ 6.01</u>
Agriculture	2.38
Construction	4.13
Trade	4.53
Business & Professional Services	3.60

a. Agriculture (Farming; Agricultural Services; Forestry and Fishing)

In the case of Japanese agriculture, the fundamental problem appears to be in the physical environment of the island nation, with the relatively small amount of arable land broken into comparatively tiny areas, most frequently surrounded by or adjacent to hill and mountain country which has built-in problems of cultivation, processing and transportation/distribution of the product. In addition, in the Japanese cultural/economic setting, farming is predominantly carried out in very small holdings, with much of the planting, cultivation and harvesting an extremely labor-intensive operation. Hence, the productivity level of the agricultural sector is extremely low; and Japan has had to rely on imported food for to a growing extent.

Even so, the demographic backbone of rural Japan (outside the relatively-limited number of huge metropolitan/industrial complexes such as Tokyo, Osaka and Shizuoka) is agricultural; and the landholders and farm workers represent an important segment of the nation's populace. Because of its low productivity, the agricultural sector of Japan has had to be supported by Government subsidies. In the present period of economic difficulty and severe budget deficits, this has presented an increasing problem. Government officials are now struggling with possible approaches to subsidy reduction to help reduce the deficit. It will be noted that real output growth of Japanese agriculture was virtually static during the 70's, just as it had been in earlier years.

The growth rates of total factor productivity and labor productivity for Japanese agriculture differed sharply, however, due to a reduction in labor input and a large increase in capital input per unit of product during the latter years of the decade. Labor productivity showed a strong rise (5.7 percent per year), while total factor productivity declined an average of 5.0 percent per year, due to heavy capital input per unit of outputs.

The United States agricultural picture offers a sharp contrast to that of Japan, more favorable from the U.S. viewpoint than perhaps that of any other sector. Due to vast areas of relatively-flat acreage and a farm-size and ownership pattern which has shifted during the past half century to very large-scale holdings, the latest cropping practices, latest and best technology in fertilization and animal husbandry and mechanized operations, agricultural productivity and total output volume is very high indeed for the

United States. The U.S. ranks as a world leader in total agricultural output, most likely now exceeding even the U.S.S.R. In terms of productivity, whether expressed in physical units of a given product per unit of labor or in terms of value added per unit of input, the U.S. is indeed the world's agricultural leader.

While the portion of the nation's population involved in agricultural activity has been steadily reduced over the past fifty years (down to about 3 percent) farm output has increased roughly two and one-half times, as has output per crop acre. Total farm output per hour of farm work, as calculated by the U.S. Department of Agriculture, has risen 5 percent per year.

Calculations published by the APC show an increase in output per hour of 4.9 percent per year for farming (excluding farm services) during the post-war span 1948-81, with total factor productivity rising 3.5 percent per year over the same period. However, between 1970 and 1980, the agriculture sector as covered in our binary comparison showed a modest increase of 1.1 percent per year, significantly below the rate of increase for Japan as well as below the trend for farming productivity in the U.S., excluding agricultural services.

However, even with the more modest 1970-80 growth rate as shown by our current computations, the relative level of output per hour for U.S. agriculture and agricultural services in both 1970 and 1980 is higher than for Japan by a ratio of more than 3 to 1. (Table 3 and Figure 4.)

b. Construction

Productivity for the construction industry for both nations was in at least relative terms a catastrophe in the 1970's. For the U.S., total factor productivity declined 2.3 percent per year, while labor productivity dropped 2.4 percent per year (one of the few instances total factor had a more favorable trend than did labor productivity).

Construction output declined in the U.S. during the post-war span, very sharply during the years after 1977, when interest rates reached unheard of levels and residential buyers, particularly, were forced out of the market by the combined effects of escalated prices for housing and mortgage interest rates.

For Japan, construction productivity declined in total factor terms by 1.4 percent per year; but labor productivity rose slightly -- 0.7 percent per year. However, despite the slightly more favorable productivity trend, Japan's level of output per hour in 1980 was only a bit more than half that of the U.S.: \$4.13 for Japan, \$7.43 for the U.S. (Table 3 and Figure 6).

c. Trade

The Japanese trade industry -- most particularly retail trade -- is another significant productivity trouble spot in the economy. While in the past decade or so Japan has introduced in some of the larger metropolitan areas huge modern department stores which to the shopper appear to be operating at a comparatively high level of productivity, that is not the characteristic Japanese retail trade mode. In past years, and even today to a

Table 3. Output and Productivity Patterns in Private Business Economy and Sectors, U.S. and Japan, 1970-80.

	Growth in Real Output 1970-80 (% per year) (% of Total Private Bus.)		Share of Bus. Output 1970 1980 (% of total pvt. bus)				Level of 1970 Output/Hr. (75\$)		Level of 1980 O/Hr. (75\$)		Average Ann. Growth Rate 1970-80 O/Hr. Total F. Pty.			
	U.S.	Japan	U.S.	Japan	U.S.	Japan	U.S.	Japan	U.S.	Japan	U.S.	Japan	U.S.	Japan
Private Business	3.1	5.5	100	100	100	100	8.27	3.59	9.27	6.01	1.2	5.3	0.6	2.3
Goods-Producing Industry:	2.4	5.6	42.8	50.4	39.9	50.6	8.37	3.14	9.68	5.99	1.5	6.7	1.0	3.5
Agriculture	1.6	0.2	4.0	6.7	3.4	4.0	6.17	1.37	7.21	2.38	1.1	5.7	-1.2	-5.0
Mining	1.5	2.5	2.2	0.8	1.9	0.6	27.57	5.07	19.25	11.67	-3.5	8.7	-2.5	4.6
Construction	0.2	3.4	6.2	10.2	4.6	8.3	9.45	3.85	7.43	4.13	-2.4	0.7	-2.3	-1.4
Manufacturing	3.0	7.1	30.4	32.7	30.0	37.7	7.92	3.91	10.17	8.00	2.5	7.4	1.7	4.9
Services-Producing Industry:	3.5	5.4	52.7	49.6	60.1	49.4	8.18	4.20	9.00	6.03	1.0	3.7	0.6	0.9
Trans & Comm.	4.7	5.0	8.0	6.9	9.3	6.5	9.29	3.86	13.13	5.67	3.5	3.9	2.8	3.2
Pub. Utilities	3.2	4.5	3.0	2.2	3.0	2.0	21.98	14.01	25.37	19.74	1.4	3.5	-0.5	-0.1
Trade	3.3	5.6	20.5	14.9	20.8	14.9	6.88	2.88	7.92	4.53	1.4	4.6	0.8	2.3
Fin. & Insurance	3.4	8.1	5.3	4.7	5.4	6.0	8.21	6.69	8.20	12.05	0.0	6.0	-0.5	4.4
Real Estate ¹	3.5	7.1	5.7	8.0	5.8	9.3	--	--	--	--	-1.0	1.1	1.2	-1.9
Bus. & Prof. Serv.	3.8	3.5	14.7	13.1	15.7	10.8	6.79	3.39	6.70	3.60	-0.1	0.6	-0.1	-2.6

Source: American Productivity Center

¹ Data on levels of output per hour are not deemed reliable for this sector, due to deficiencies in the estimate of hours input, for both the U.S. (BLS estimates) and the JPC estimates, time devoted to sales by non-office sales personnel are excluded. These outside salesmen constitute decidedly over half of all the employees of the sector. Their contribution to gross income for the industry is reflected in the output, but not in the input. It appears likely that this deficiency does not exert major effect upon trends, however.

predominant degree, retail trade is carried out in Japan much as it was a half century or more ago, and as it is still practiced in most of Latin America, the Middle East and other Asian nations: small specialty shops, with modest stocks limited to a particular line of merchandise or produce.

Retailing in this mode tends to provide a significant amount of individual attention and frequently customer satisfaction. However, from the customer's viewpoint, he has to visit many shops rather than one or two. From the retailer's viewpoint, the limited volume of specialized merchandise he can sell sharply limits the total volume of sales and hence his "productivity" in terms of real value of output per day or per hour of work. While this still-dominant retail trade pattern may be preferred by a majority of Japanese consumers, it appears more likely to be modified in coming years than is the case with agricultural production.

In the case of wholesale trade and distribution, the pattern is sharply different in major segments of the total activity; and Japanese wholesale trading and distribution appear to be more efficient in at least some aspects than those of the their U.S. peers -- most especially in the international marketing picture, where the huge Japanese trading houses operate with great skill and efficiency, and tend to truly dominate both import and export marketing for the nation. (In this context, it would appear that the United States may have much to learn from Japan.)

In terms of productivity growth, Japanese trade sector productivity (both total factor and output per hour) grew three times as rapidly as did U.S. trade. However, due to the very low Japanese level of output per hour in 1970 (\$2.88 per hour, above only the nation's agricultural sector), her level in 1980 was still only about 55 percent that of the U.S. (\$4.53 versus \$7.92). (Figure 7 and Table 3).

d. Business, Professional and Other Services

Growth in real product of the business and professional services sector grew at nearly the same pace in the United States and in Japan; but share in total output of the private domestic economy for this sector rose in the U.S. but declined in Japan, due to the more rapid output growth in Japanese manufacturing. In 1980, output share of this relatively large services sector accounted for 15.7 percent of the output of the U.S. business economy, and 10.8 percent for Japan. (Table 3 and Figure 8).

Growth of productivity in this important services sector was dismal in both nations, with the U.S. labor productivity performance poorer than that of Japan (-0.1 percent vs. +0.6 percent) but total factor productivity for the Japanese sector declining over the decade more rapidly than that of the U.S. (-0.1 for the U.S. vs. -2.6 for Japan). While we lack detail as to the specific causes, Japan's total factor productivity slump was clearly traceable to an extremely heavy rise in capital input per unit of product, which for this sector was not reflected in significant increases in either labor or total productivity. (Figure 8).

Japan's absolute level of real output per hour, a very poor \$3.39 in 1970, had risen only to \$3.60 in 1980 -- just over half the U.S. level of \$6.70 in 1980.

This sector is an amalgam of a wide variety of services, ranging from educational, scientific, engineering, medical, legal and consulting services, to household and personal services. While we lack specific data, it appears likely that it is in the latter category -- personal and related services -- that much of Japan's productivity disadvantage presently is centered. In Japan, in personal services just as in retail trade, emphasis is upon truly personal attention, with relatively little emphasis upon "efficiency," whereas in the United States even the personal services category has been "Taylorized" to a very large extent, with emphasis upon fast completion of the operations and maximum "efficiency" rather than on complete customer satisfaction. (We do not wish to pass judgment herein whether this is "good" or "bad" from the viewpoint of national economic health.)

It appears likely that in the "professional services" area, Japanese productivity and relative efficiency is fully equal to that of the United States.

e. Transportation and Communications

This is another composite sector for which we lack full detail and specific information as to factors which influenced Japan's productivity dynamics. We do know that for the United States, the communications sector was one of the most productive sectors in the business economy, in both level of output per hour and in productivity growth rates in recent years, due to unusually extensive and rapid introduction of new technology.

The U.S. transportation sector has also fared relatively well in development and productivity growth despite the productivity and profitability performance of the chronically sick railroad industry. The sector's performance certainly cannot match the pace of the communications sector.

For Japan, we know that extremely significant breakthroughs have been achieved in rapid transportation during the post-war years -- with the Japanese Shinkansen (bullet trains) showing the world the way to efficient, superfast rail transportation. In over-the-road transportation, Japan's physical topography and the break-up of the nation into many individual islands may have limited the achievement of the same high levels of output per unit of input which have been possible in the U.S., Germany and one or two other Western European nations. Also in the transportation segment of the economy, Japan's metropolitan rapid transit systems at least a decade or so ago were the equal in quality and performance to any in the entire industrial world -- and perhaps the best.

However, information provided by Peter Drucker in a recent book points the finger at Japan's nationalized rail transportation system -- the Japanese national railroad -- as the "principal villain in the Japan's transportation sector productivity problems." According to Drucker, "the government-owned Japanese National Railroad (JNR), whose deficit by itself accounts for 18 percent of the Japanese national budget . . . is a perfect parody of the beatitudes of Japanese management we hear so much about. It has the least harmonious labor relations of any large enterprise in the noncommunist world, save, perhaps, for the British National Coal Board and British Motors. It is grotesquely overstaffed, with several times as many employees per revenue

mile as any other railroad system . . . JNR has lost practically all of Japan's freight traffic: less than 8 percent of Japan's freight moves by rail, compared with some 40 percent in the U.S. Now it is rapidly losing passengers, too, especially to the private railroads which, around the big cities, often parallel the JNR tracks...."¹

Again, we emphasize that we lack hard factual evidence as to the reasons for relative strengths and weakness of the Japanese transportation and communications sectors of the economy. Dr. Drucker's comments, however, may at least indicate some of the problem which limits the level of output per hour for this segment of the economy.

In the specific area of communications, the U.S. advance in technology has without question been the world's most rapid and extensive, taking into account not only space technology and orbiting communications satellites, but also advanced micro-technology; and new impulse-transfer in cable communications; lasers; and computerized telecommunication networks. Japan, however, has also been forging ahead in the adaptation and utilization of high technology in this important area. In addition, Japan has been among the world leaders in shaping efficient national information transfer networks and in the practical, in-depth applications of the latest and best information/communications rapid storage/retrieval/instantaneous transfer applications.

From the data available in our binary comparison of productivity levels and trends, U.S. output per hour in the composite transportation/communications sector rose from \$9.29 in 1970 to a high \$13.13 in 1980. (It appears worth noting, however, that the composite for the transportation and communications sectors cloaks the fact that for the United States, output per hour for communications industry was more than double the level of the U.S. transportation sector; in 1981, \$20.61 versus \$8.10 in 1972 dollars).

Japan's record shows a rise from a poor \$3.86 in 1970 only to a modest \$5.67 in 1980. In our judgment, both levels may be an understatement of Japan's true efficiency and technical achievements in this important area of the economy. (Table 3 and Figure 9). Productivity growth rates 1970-80 for this sector were 3.5 percent per year for the U.S. in labor productivity, versus 3.9 percent per year for Japan; and total factor productivity, 2.8 percent per year for the U.S., and 3.2 percent for Japan.

f. Public Utilities (Electric, Gas and Water)

Public utilities, a highly capital-intensive sector of the economy, recorded an output per hour level in 1980 of \$25.37 in 1980 for the U.S. and \$19.74 for Japan -- both far higher than that of any other sector of the business economy. In past years, the public utilities industry in the U.S. has been one of the consistent leaders in both growth rate and level of output per hour, which is also true to a more limited extent in Japan.

¹ Drucker, Peter F. "Clouds Forming Across the Japanese Sun," Wall Street Journal, July 13, 1982.

However, during the 1970's the productivity growth leadership of the public utilities industry disappeared under the impact of OPEC-induced shortages and price escalations for petroleum; mandated curtailment of energy usage of all types (especially electrical energy); and interest rates at previously unheard-of levels, forcing slowdowns in planned capital investments. Also, for the public utilities industries of both U.S. and Japan (but with the impact in the U.S. much more severe) conflicting federal government mandates on reduction of coal consumption (for environmental clean-up) and oil conservation (due to the OPEC shock) led to severe disruptions of normal plant maintenance and operating schedules.

As the result of this combination of adverse influences -- and others which are not cited herein -- productivity in the public utilities industries slumped badly after the OPEC-shock period. Labor productivity, which had been rising rapidly throughout the post World War II period -- rose only 0.2 percent per year during 1973-80 in the U.S.

In contrast, the Japanese industry, which had been expending large sums of capital for improving efficiency and coping with pollution control mandates, achieved an increase in labor productivity of 4.9 percent per year during this same period. In terms of total factor productivity (reflecting the input of capital as well as of labor) the 1973-80 growth rates were a -1.0 percent per year for the U.S. and +0.8 percent per year for Japan. (Table 3 and Figure 10).

g. Finance and Insurance

The finance/insurance sector in Japan has witnessed strong growth in output and in productivity during the decade of the 70's; and is now the only Japanese service sector which exceeds its U.S. counterpart in the absolute level of labor productivity (\$12.03 versus \$8.20 for the U.S., both in constant 1975 dollar equivalents). In its rapid growth during the 70's, Japan's finance and insurance industry rose 8.1 percent per year in real value of output, gaining an increase in its share of private domestic business from 4.7 percent in 1970 to 6.0 percent in 1980. Its productivity rose 6.0 percent per year (labor productivity) and 4.4 percent per year, total factor productivity. (Table 3 and Figure 11).

In the U.S. this sector recorded a reasonably good increase in output of 3.4 percent per year, increasing its share of total business output slightly, to 5.4 percent. However, its productivity growth performance was thoroughly undistinguished in the 70's, with an average per year (change) of 0.0 percent in labor productivity and a -0.5 percent per year in total factor productivity. Thus, its 1970 productivity level advantage over its Japanese counterpart (\$8.21 versus \$6.69) completely disappeared.

We lack detailed information as to the causes of the productivity growth differentials for this sector. However, it is obvious that the Japanese industry coped better with the economic/financial shocks of the 70's better than did the U.S. industry. We suspect -- but without specific evidence -- that the relative advantage of the Japanese industry was due in large part to the direct support of the Federal government, through its intervention in and partial control of the inflow of investment funds and their channeling through the Japanese development bank and through other major financial

institutions whose decisions were governed at least in part by the Federal establishment.

h. Mining

The relatively small mining sector for both Japan and the United States has some extremely interesting productivity patterns. On one hand, the estimated level of output per hour for the mining industry in the United States was far and away the highest in either economy at the start of the decade, at \$27.57 per hour, while for Japan the level was estimated at only \$5.07 per hour.

During the decade, however, the U.S. mining industry was impacted by a particularly severe series of problems, including extremely substantial and sometimes conflicting federal regulations on employee health/safety and on environmental control. These mandates were obviously inescapable during a period in which the nation was attempting to overcome past slippages in dealing with social ills, and the mining industry was perhaps the largest contributor to worker's problems of health and longevity. The industry's efforts to cope with adjustments were complicated by severe labor unrest and prolonged work stoppages, not unrelated to the health/safety conditions. These stoppages, of course, were detrimental to measured productivity, due to the direct relationship of productivity and utilization of capacity.

Also, the U.S. coal mining industry was afflicted by the impact on demand for its product due to changing environmental regulations and the energy crisis. In the late 60's and early 70's, government regulations severely restricted the amount of coal which could continue to be used by many basic industries, as a step toward reduction of air pollution. Later, after the crude oil crunch, both public utilities and manufacturing industries were pressured to switch back to coal usage. Demand for other products of the industry -- especially iron ore -- were adversely affected by the severe drop-off in demand and output of steel.

As a consequence of these problems, real output for the mining sector rose only 1.6 percent per year over the decade, the lowest for all sectors except the increasingly-ill construction sector. The mining sector's share of output of the private business economy fell from 2.2 percent to 0.9 percent -- the lowest of all the nation's major sectors.

The output drop was accompanied by sharp and steady declines in productivity, as measured in terms of total factor, labor or capital productivity: -3.5 percent per year labor productivity, -2.5 percent total factor and -0.1 percent per year, capital productivity.

For Japan, we have less detailed information on the influences determining productivity trends. However, the Japanese industry, which is much smaller than that of the U.S., was certainly impacted in some of the same ways by federally-mandated actions to improve worker health and safety and to improve the environment, through apparently not to the same degree. Since Japan has no coal mining industry, the sector was not impacted by the severe combination of problems which affected U.S. coal mining.

During the decade, the mining sector's relatively small output volume rose modestly (2.5 percent per year). Its labor productivity grew at an extremely strong 8.7 percent per year rate -- hence its level of output per hour in 1980 reached \$11.67 per hour, still well below its U.S. counterpart but far higher than those of any other sectors except utilities and finance/insurance. (Table 3 and Figure 12).

2. Manufacturing Industry: The Sector and Major Industries

In terms of output and productivity performance of the individual sectors, the most significant is undoubtedly the performance of the Japanese manufacturing sector contrasted to U.S. manufacturing. In Japan, the expanding manufacturing sector accounted in 1980 for nearly two-fifths of the total output of the private business economy, an increase of a full 15 percent from its relative share in 1970. The output share for manufacturing was one-third higher than for trade and business/professional services combined; and more than three-fourths the share for all services sectors.

In the U.S., the manufacturing share was held at three-tenths of the total for the business economy, dropping very slightly from 1970 to 1980. At the close of the decade, U.S. manufacturing output was slightly under one-half that of the services industries' total; and significantly below the total for the large trade and business-professional services sectors.

This differential in manufacturing industry's output share and the pace of its growth over the decade had a direct and highly significant bearing upon international merchandise exports and their contribution to the two nation's GNP and standard of living. During the decade of the 70's, exports of Japanese manufactured goods rose from \$18.1 to \$124.4 billions of U.S. current dollar equivalents, reaching in 1980 nearly nine-tenths of the U.S. total. According to computations recently made by the American Productivity Center, Japan's exports of manufactures in "real" (or constant-dollar) value rose over 14 percent per year during the decade, nearly double the manufacturing exports growth rate for the United States.

As previously noted, the decade of the seventies was indeed an unusual and difficult period for manufacturing industries, in both the United States and Japan, even more than for most other sectors. In Tables 4 and 5, we have attempted to present growth-rate data which help to highlight the effect of varying impacts on productivity growth during four distinct cycles of the decade:

1970-73: A relatively happy period during which the manufacturing industries in both nations recorded extremely strong growth in real output and in productivity, based on recovery from the temporary output slump resulting from the short recession at the turn of the decade.

To some extent, also, industry was still riding the crest of the "golden era" of productivity and national growth following the end of World War II. Economists, industrialists and consumers had shrugged off the 1969-1970 trough as a temporary aberration in a presumably-permanent beneficent upward growth path in profits, wages and the standard of living. For many

industry segments, 1973 witnessed the historical peak of their productivity levels never achieved before, and unfortunately never since recovered.

- 1973-75: Disaster following euphoria! Already extant but unrecognized economic problems which had shaped in the late 1960's were violently and abruptly escalated by the OPEC embargo in October 1973 on crude petroleum shipments; and the subsequent quintupling of average oil prices.

While it was not recognized at the time, this put an end to a roughly two-century era of plentiful cheap energy; and terminated -- at least temporarily -- the long-term trade-off of embodied capital for human labor.

The world's industrialized nations plunged together into recession, which differed only in degree and its precise timing, as they struggled to cope with problems more severe than any since the great depression of the thirties.

- 1975-78: A period of hesitant recovery from the recession, marked by large differences in both the timing and extent of recovery between nations and between the sectors and industries within each nation; and, finally

- 1978-80: The decade ended with economic snarls and whimpers, as the second oil shock of 1979-80 forced a quadrupling of the already-escalated energy prices, with crude oil at a level roughly ten times that of 1972; and all energy four to five times the earlier rates. The hesitant recovery from earlier woes was succeeded by a severe "double-dip" recession in 1980-81, which is continuing to afflict all major industrial nations in the third quarter of 1982. There is still a very real question as to the ability of the leaders of the world's major industrial nations to cope with these problems in a way to assure sound continuing economic growth.

A productivity growth determinant which affected each of the various manufacturing industry groups during the seventies in differing ways and to a differing degree is the manner in which Government mandates for environmental improvement and employee health/safety have affected both the expenditure of capital for industry and the necessary adjustments in operational techniques and procedures. In terms specifically of diversion of available capital to meet mandated environmental control needs, in the U.S. the primary metals, chemicals, petrochemicals, petroleum, paper and public utilities industries were affected much more heavily than were the other manufacturing industry groups, or any of the service industries other than public utilities.

While this was only one of the determinants of differential productivity growth, it constituted a significant item when added on top of other problems, noted herein, including the energy crunch, aging machinery and equipment, and declining utilization of plant capacity due at least in part to unsuccessful international marketing competition.

Especially in context of a U.S./Japanese comparison, two points seem worth emphasis with respect to the relationship between a slowdown in productivity growth due to the diversion of sizeable amounts of available investment capital, to conform to Government mandated regulations:

- o The total amount of investment capital available to U.S. industrialists, as a percent of GNP, is sharply lower in the U.S. than in Japan; and competition for it is more severe -- especially in context of Japanese Government subsidization of investment capital at very low interest rates and the escalating interest levels prevalent in the U.S.; and
- o By all reports, while Japanese environmental control regulations in the 70's were just as severe as those of the U.S. -- and their application reportedly even more successful -- the manner in which they were installed appeared less disruptive to labor productivity as conventionally measured. Without exception, qualified observers who are familiar with industrial practice in both the U.S. and Japan have stated that the Japanese government sets standards to be achieved; but the industrialists make the decisions on how the adjustments can be made with least adverse productivity impact. In the U.S., this is not the case. Also, in the U.S., directives from the Energy Agency on oil conservation have been in direct conflict with environmental control directives to eliminate air pollution through the use of coal, with industry caught in the middle.

a. Total factor productivity

In reviewing the pattern of industry productivity growth rates, it is noteworthy that all industries in both the U.S. and Japan recorded increases in total factor productivity during 1970-73 -- a period in which the U.S. industry's performance was relatively stronger in comparison to Japan's than during the 60's or in the later phases of the 70's. The U.S. TFP rise for manufacturing averaged just one percentage point below Japan's; and for four of the ten groups, the U.S. rate exceeded Japan's -- textiles, pulp/paper, transportation equipment and "other" manufacturing -- which includes eight different industry groups as classified by the Census of Manufactures. (A finer breakdown was not possible because of differences in measurement scope for the two nations.) (Table 4 and Figure 13).

For three major industry groups, however, Japan's TFP growth rate was far above that of the U.S. -- chemicals, fabricated metals products and electrical machinery.

During the recession years 74 and 75, all manufacturing groups in the U.S. and all but four in Japan recorded significant declines in total factor productivity, ranging up to 7.8 percent per year for primary metals in the U.S., and 9.6 percent per year for fabricated metals products in Japan.

The third (1975-78) period witnessed a general recovery from the recession, ranging from very modest (0.7 percent per year in Japanese textiles and 0.1 percent and 1.0 percent in U.S. food/tobacco and primary metals) up to very large indeed in the case of chemicals and electrical machinery (over 17 percent) in Japan.

Table 4
Trends in Total Factor and Capital Productivity of
Manufacturing Industry in the Seventies: U.S. and Japan

Industry Group	Average Annual Growth (Percent per year)							
	Total Factor Productivity				Capital Productivity			
	1970- 73	1973- 75	1975- 78	1978- 80	1970- 73	1973- 75	1975- 78	1978- 80
All Manufacturing:								
U.S.	5.4	-2.3	2.8	-1.1	5.0	-9.0	3.3	-4.7
Japan	6.4	-0.7	6.4	6.2	-1.9	-9.8	1.6	4.3
Food & Tobacco:								
U.S.	7.3	-1.7	0.1	4.2	5.2	-4.1	-1.2	2.8
Japan	7.8	1.8	-4.8	6.6	-1.9	-4.1	-7.4	3.1
Textiles								
U.S.	2.9	-2.2	7.8	-0.2	2.4	-9.4	8.8	-2.4
Japan	1.8	13.3	0.7	5.4	-6.7	3.0	1.1	3.1
Pulp & Paper								
U.S.	8.8	-5.1	3.1	-2.6	8.1	-11.7	2.7	-6.7
Japan	7.6	-3.4	4.1	-1.2	-0.8	-12.9	1.6	-4.6
Chemicals								
U.S.	8.0	-2.0	2.6	-1.0	6.7	-4.2	1.3	-3.4
Japan	11.6	-4.2	17.3	-3.3	4.6	-9.8	13.5	-3.3
Primary Metals								
U.S.	5.5	-7.8	1.0	-2.4	5.9	-14.7	2.2	-7.2
Japan	9.3	-4.8	4.0	10.9	1.6	-10.9	-0.3	11.7
Fabricated Metals Products								
U.S.	2.7	-4.8	3.4	0.2	2.1	-13.7	4.0	-5.1
Japan	12.2	-9.6	9.0	-2.6	-2.1	-26.4	3.8	-5.5
Machinery, except Electrical								
U.S.	2.9	-2.5	2.7	-1.0	2.4	-8.2	2.4	-4.2
Japan	3.0	4.2	9.7	6.1	-3.7	-9.2	6.7	5.9
Electrical Machinery								
U.S.	4.7	-2.1	7.3	0.7	3.1	-10.8	9.0	-2.4
Japan	19.3	-1.6	17.9	18.3	13.2	-10.8	16.3	14.8
Transportation Equipment								
U.S.	8.9	-2.0	4.2	-8.8	8.4	-10.2	5.6	-16.0
Japan	1.6	4.8	5.8	8.4	-5.5	-3.8	3.8	6.7
Other Manufacturing								
U.S.	4.2	-0.9	1.3	-0.5	3.7	-5.3	2.3	-3.9
Japan	1.7	-1.5	3.9	-1.2	-6.0	-7.9	1.5	-5.0

Source: American Productivity Center

Table 5
Manufacturing Labor Productivity Dynamics
in the Seventies: U.S. and Japan

Industry Group	1970 Output \$ Per Hour ¹	Average Annual Growth Rates				1980 Output \$ Per Hour
		1970- 73	1973- 75	1975- 78	1978- 80	
All Manufacturing:						
U.S.	7.92	5.5	0.2	2.6	0.4	10.17
Japan	3.91	9.4	4.0	7.8	6.6	8.00
Food & Tobacco:						
U.S.	9.51	8.2	-0.7	0.1	4.9	13.35
Japan	3.81	13.8	6.7	-3.2	10.4	7.07
Textiles						
U.S.	5.11	3.1	0.4	7.5	0.6	7.10
Japan	1.58	4.8	18.3	0.5	6.6	2.93
Pulp & Paper						
U.S.	8.28	9.1	-2.4	3.3	-0.6	11.16
Japan	5.11	11.7	2.9	6.2	0.9	9.20
Chemicals						
U.S.	10.26	8.7	0.4	3.4	0.6	14.91
Japan	6.54	17.0	0.4	21.6	-3.3	17.77
Primary Metals						
U.S.	11.51	5.4	-5.8	0.7	-0.8	12.01
Japan	8.61	15.3	2.0	9.0	9.8	21.43
Fabricated Metals Products						
U.S.	8.53	2.8	-2.6	3.3	1.8	10.05
Japan	3.32	13.5	-12.4	6.0	-2.1	4.75
Machinery, except Electrical						
U.S.	8.54	3.0	-0.8	2.8	0.2	10.04
Japan	4.93	4.5	7.1	10.4	6.1	7.98
Electrical Machinery						
U.S.	6.90	5.0	0.6	6.8	1.7	10.22
Japan	2.78	21.9	3.7	19.0	20.9	13.32
Transportation Equipment						
U.S.	8.47	9.0	0.5	3.8	-6.2	10.90
Japan	5.19	4.3	9.2	7.0	9.4	10.30
Other Manufacturing						
U.S.	6.56	4.4	2.2	0.8	1.4	8.23
Japan	3.83	3.6	1.8	4.8	0.4	5.13

1. Real (constant U.S. 1975 \$) gross domestic product per hour, equivalents.

Source: American Productivity Center

The final -- 1978-80 -- period in the decade showed a much larger variance in both direction and size of TFP productivity changes. In the case of the U.S., all manufacturing averaged a drop of 1.1 percent per year, in sharp contrast to Japan's average increase of 6.2 percent per year. In the U.S., only three groups (food/tobacco, fabricated metals products and electrical machinery) avoided losses in productivity -- all others recorded declines, ranging up to 8.8 percent for the severely-impacted transportation equipment industry, with the automobile segment leading the way. For Japan, six of the ten groups recorded sharp increases in TFP: 5.4 percent, textiles; 6.1 percent, machinery except electrical; 6.6 percent, food and tobacco; 8.4 percent, transportation equipment; 10.9 percent, primary metals; and a fantastic continued gain for electrical machinery of 18.3 percent per year.

b. Labor Productivity

1. Trends

In general, labor productivity growth rates were more substantial than those for total factor productivity. (This is to be expected, since total factor productivity includes the reflection of inputs of capital as well as labor; and it is "embodied capital" which leads to the improvement of labor productivity). The pattern of growth rates during the four specified sub-periods, however, was relatively the same as that for total factor productivity, except that in the recessionary period, the sharp drops in output and in utilization of plant capacity led to much sharper declines in capital than in labor productivity, since the former is less flexible to adjustment in down periods. Similarly, the highs in productivity growth rates in favorable periods are in general higher for labor than for capital productivity.

This fact shows up very markedly during the "good" or "growth" period 1970-73 and 1975-78, especially for the chemicals, electrical machinery, fabricated metals and primary metals products, where Japan recorded growth rates at the earlier unheard-of annual rates of 21, 19, 20, 17, 15, 13 and 12 percent per year.

As can be noted in Table 2, over the entire decade electrical machinery (17.0 percent), chemicals (10.5 percent) and primary metals (9.5 percent), at annual rates, were the labor productivity growth leaders for Japan -- which of course was the reason for their outstripping the U.S. in absolute levels by the decade's end. While no single industry group in either the U.S. or Japan recorded a productivity decline over the decade, the growth rate in three U.S. groups was so low that in effect productivity was virtually flat: primary metals, 0.4 percent per year; machinery except electrical, 1.6 percent and fabricated metals products, 1.7 percent. The most "rapid" labor productivity growth rate in U.S. manufacturing industry was the 4.0 percent recorded by electrical machinery -- a pace which was exceeded by no less than 8 of the 10 Japanese groups.

As noted elsewhere in this document, we deem it no coincidence that the productivity growth stars in Japanese manufacturing are those specifically targeted by the Government's development efforts, such as steel, chemicals, computers, large and small electrical machinery, calculators, computers, robotization, and information storing/retrieving and rapid dissemination equipment.

2. Comparative levels

In 1970, all manufacturing industry in the U.S. generated an output of \$7.92 per hour of labor input, compared to Japan's level of \$3.91.¹ The U.S. output per hour levels for individual groups in 1970 ranged from highs of \$11.51 for primary metals and \$10.26 for chemicals down to \$5.11 for textiles. For Japan, comparable figures were from a high of \$8.61 (U.S. dollar equivalent) down to \$1.58 for textiles. (All figures in constant 1975 U.S. dollars per hour). (Table 5).

It is distinctly worth noting that the level of labor productivity in the important manufacturing sector of Japan is comparatively high; and is exceeded in measured output per hour only by Japanese public utilities, mining and the finance/insurance sector. The latter, like manufacturing, has shown remarkable growth in output per hour during the 70's. (This sector is, in fact, the only one in which the Japanese sector's absolute level of output per hour exceeded its U.S. counterpart; and it has done so since 1972.)

By the end of the decade, manufacturing productivity had reached an output per hour level a full 80 percent that of the United States -- far above the relative level for the total domestic economy and for all private business.

Even more significantly from the viewpoint of capability to compete in world trade, by 1980 Japan's productivity had exceeded that of the U.S. in three truly major manufacturing industry groups: primary metals (including steel); chemicals; and electrical machinery. Further, its productivity in the important transportation equipment group was so nearly equal that of the U.S. industry that any remaining U.S. advantage may be based on statistical error rather than fact. Informed observers, both U.S. and Japanese, have determined that in the manufacture of cars and trucks, the Japanese productivity growth of the 70's has led to current levels of output per hour which are far higher than those of U.S. producers -- ranging up to 2 to 1 for some comparable automobiles.

The relative 1980 levels of output per hour for these key groups appears as follows:

¹ As in all measures of productivity, these figures should be regarded as "best approximations" or "estimates," rather than precise. This is deemed even more applicable to measures of level than of trends, since potential weaknesses in estimated output and inputs can affect estimates of comparative levels more than those for trends. However, the figures are presented in the conviction that the differences in U.S. and Japanese levels are indeed very real; and figures shown are "in the ballpark."

<u>Industry Group</u>	<u>Output per hour in 1980</u> <u>Real (1975 \$)</u>	
	<u>Japan</u>	<u>U.S.</u>
Primary Metals	\$21.43	\$12.01
Chemicals	17.17	14.91
Electrical Machinery	13.22	10.22
Transportation Equipment	10.30	10.90
Pulp and Paper	9.20	11.16

3. The Steel Industry, A Special Case: Productivity, Costs and World Market Share

The steel industries of the United States and Japan, which are one of the most important and basic industries of both nations, provide a dramatic contrast in their developmental paths during the past two decades:

In 1960, the U.S. steel industry towered above its competitors, with an annual crude steel output of 90.1 million metric tons, about one-fourth above its nearest competitor (the U.S.S.R.). The U.S. steel output was almost as large as the total for the European Economic Community; four times the level of the United Kingdom; nearly three times that of West Germany; and over four times the output of Japan's steel industry.

Growth rates changed rapidly during the ensuing years, however. When the U.S. steel industry reached its all time peak in 1973, the U.S.S.R. was at nearly the same volume; and it exceeded the U.S. in all ensuing years.

The rapidly expanding Japanese steel makers nearly equalled the recession-impacted U.S. level in 1975, with a differential of a mere three percent between them. The U.S. industry remained above a depressed Japanese steel industry through 1979; but in 1980, Japan's output held almost level with the 1979 volume, at over 111 million metric tons, while the recession-plagued U.S. industry fell to under 101 million tons.

	<u>Crude Steel Output ¹</u> <u>Selected Years</u>		
	<u>U.S.</u>	<u>U.S.S.R.</u>	<u>Japan</u>
1960	90.1	65.3	22.1
1973	136.8	131.5	119.3
1975	105.8	141.3	102.3
1979	123.3	149.0	111.7
1980	100.6	N.A.	111.6

¹ In millions of metric tons.

Source: National Foreign Assessment Center, Handbook of Economic Statistics.

While we unfortunately lack reliable total factor productivity measures for the U.S./Japan steel industry comparison, there is an excellent array of data on levels and trends in labor productivity, compensation and unit labor costs which help to explain the problems which afflicted the U.S. steelmakers and cut away their world market share:

- o Labor productivity for the U.S. steel mills, estimated by the Bureau of Labor Statistics at 81 tons per hour in 1964, was then more than double the amount estimated for Japan, France and the United Kingdom; and almost double that for West Germany. By 1980, however, France had risen to roughly 90 percent of the U.S. level and Germany's level was above the U.S. rate. Japan's steel industry had outstripped all other major nations from the mid-70's onward. The BLS estimates record Japan's "minimum" level in 1980 at 128% of the U.S.; and the "maximum" at a full 155 percent:

Estimates of tons per hour, hourly labor cost
and relative unit labor costs, all employees
U.S. and Japan, 1964 and 1980

	Output/Hour (in 000 short tons)		Percent of U.S., 1980	Labor Cost/hr. (in U.S. \$) ¹		Percent of U.S., 1980	Unit Labor Cost (U.S. \$ short ton)		Percent of U.S., 1980
	1964	1980		1964	1980		1964	1980	
U.S.	81.18	96.36		\$4.63	\$17.48		\$57.00	\$183.20	
Japan:									
Minimum	35.98	123.34	128	0.74	9.09	52	18.10	62.29	34
Maximum	41.20	149.36	155	0.75	9.26	53	20.71	75.11	41

Basic Data: U.S. Bureau of Labor Statistics

¹ For all employees

Taking a look at comparative Japan/U.S. labor productivity growth rates over the full two decades for the steel industry (average percent per year):

	1960-73	1973-80	(1970-73)
U.S.	2.7	-0.4	(6.7)
Japan	11.4	3.7	(11.7)

During the period up to the 1973 OPEC cartel's petroleum embargo and the subsequent oil-price escalation, U.S. steel showed a growth rate which was comparatively good among the U.S. manufacturing industries, especially in its strong recovery from the 1970 recession, with a growth rate of a full 6.7 percent per year 1970-73. Following the OPEC-induced energy crisis, however, U.S. steel productivity fell into a decline which averaged a negative growth of 0.4 percent per year 1973-80.

In sharpest contrast, Japan's steel industry recorded a truly fantastic growth rate of over 11 percent per year during the full 1960-73 span, including a pace of almost 12 percent per year in 1970-73.

- o The productivity catastrophe of the US steel industry, generated by causes which will be touched upon below, was accompanied by a tremendous escalation of costs, for both labor and other inputs, due to the rampant inflation of the 70's. In terms of hourly labor cost, the level for the U.S. steel industry rose from \$4.63 per hour in 1964 to an estimated \$17.48 (all employees) in 1980, well above the indicated hourly compensation rates for any other major industrial nation except Germany.
- o For Japan's steel industry, however, even though wage rates rose sharply during the two-decade span 1960-80, compensation remained far lower than that of the U.S. industry. BLS estimates indicate that compensation for all employees of the steel industry, which was the equivalent in the U.S. dollars of only 75 cents per hour in 1964, had risen only to about \$9.26 per hour in 1980, just over half the U.S. level.
- o When Japan's extremely-rapid productivity growth rates are coupled with her low compensation levels, the full advantage accruing to her steel industry in unit labor cost terms is very substantial indeed. BLS data indicate that whereas U.S. steelmakers paid approximately \$183.00 compensation per ton of steel in 1980, the "maximum cost" Japanese steelmaker paid an estimated yen equivalent of \$75.00 U.S. dollars -- only two-fifths as much.

A careful look at the causes for these vast differences in output per hour, unit labor costs and trend in aggregate output of crude steel is certainly warranted. In general, it is fair to state that the U.S. steel industry was afflicted by a number of the same basic influences which slowed productivity in most U.S. industries. However, it is apparent that the steel industry shared with one of its major customers, the automobile industry, very special problems which were not common to many other U.S. industries. We cite below a number of the more obvious factors which contributed to the U.S. steel community's downfall:

- o The U.S. steel industry, as one of the larger and older basic U.S. industries, and one which requires an extremely heavy input of capital per unit of output, can honestly be accused of a basic problem of maturity, a sort of "hardening of the arteries." The average age of the U.S. steel plant is very high -- perhaps among the highest of all U.S. industries. With the acknowledged U.S. leadership in steel-making, and the huge sums which would have been required to introduce on a large scale some of the basic new technologies which had emerged after World War II, it is not too surprising that only relatively-limited funding was expended for new forms of machinery and equipment. After the industry began to feel the pinch of international competition in the late 60's and the early 70's, the impact of inflation -- with interest rates rising to unheard-of highs in the mid and late 70's -- and the disruption of normal operating patterns by the energy crisis made the rapid introduction of new plant even more of a problem.

To a degree which is recognized but not quantifiable, the drive on the part of the U.S. steel industry's leadership to improve their plant and equipment and their work methods was lacking, especially on the part of the older top managers, who were quite convinced that the U.S. steel industry had been for many years and would continue to be the best in the world. The very real competitive threat from Japan, Korea, and some of the Western European nations was held to be a factor primarily of a labor cost advantage, not the result of any differential in true efficiency or productivity -- much less of "management style."

- o The collapse of output volume and demand for steel on the part of the U.S. automobile industry severely dented the domestic steel market. That, plus the growing volume of European and Japanese steel marketing both in the U.S. and overseas led to large drops in the capacity utilization of the steel industry -- which in turn adversely impacted productivity and thus contributed to rises in unit labor costs.
- o Vigorous bargaining by the steel unions, plus cost of living escalators in existing contracts triggered by the rapid inflation of the 70's, forced steel industry compensation rates to ever-new highs, further eroding price competitiveness.

While the U.S. steel industry was holding relatively fast to its out-dated plant, the Japanese were making dramatic strides in wiping out even relatively young (by world standards) plant and introducing major new technologies. Even before the OPEC oil shock, the Japanese industry was introducing a growing number of huge new basic oxygen furnaces, which are far and away more efficient than older furnaces.

Also, Japan became the world leader in applying the continuous casting process to steel production. This technique not only improves productivity substantially, but also is a major contributor to energy efficiency, since the intermediate step of casting ingots (which must be cooled, rehandled and reheated) is eliminated.

The already active Japanese technological improvement program in the steel industry was markedly accelerated and expanded by the OPEC energy crunch; and Japan's equipment innovation focused directly on energy conservation accompanied by improved productivity.

According to information provided in a recent report by Mr. Robert A. Hageman of Kidder, Peabody and Company, based on a 1981 visit to Japan, that nation now tops the world in the number of very-large basic oxygen furnaces with capacity of more than two million cubic feet, with a total of 39. (The U.S.S.R. reports 30; West German 8; the U.S. 7; and all other countries a total of 38). In all, Japan's industry in 1980 had a total of 94 basic oxygen furnaces; 627 electric furnaces; and had eliminated entirely the less-efficient open hearth furnaces.

The excellence of the information Mr. Hageman has provided in his paper has motivated us to quote directly his observations on recent technological advances introduced in the Japanese steel industry, including those related

directly to energy conservation (which were mentioned briefly in our earlier section on energy productivity):

"Among the measures adopted to expand the number of steel grades produced and enhance their quality have been the dynamic control of BOF's; ultra-high power operation of electric furnaces; the use of oxygen injection and vacuum degassing equipment; and the introduction of automated systems for many of the production processes. The first pure-oxygen, bottom-blown (Q-BOP) furnace vessels were introduced in 1977, with some of them being able to go through more than 2,000 heats before being relined with new refractory bricks. This compares with older experiences of 350 heats before relining. These vessels have also increased the yield by 1.3 percent and resulted in energy savings of \$7 a metric ton.

"Japan also leads the world in continuous casting. Table 9 shows that continuous casting machines numbered 141 at the end of 1980. As a result, the continuous casting of slabs, billets, and blooms in Japan accounted for 60 percent of crude steel production, compared with 46 percent in West German, 27 percent in the United Kingdom, and 20 percent in the United States. Japan is now lending technical assistance to several U.S. steel producers on various continuous processes for the making of steel.

"Slag (waste matter) from blast furnaces (BF) has historically been a major problem for steelmakers. During 1980 about 27 million metric tons of slag resulted from blast furnace production in Japan. Nearly all of it was utilized: about 45 percent was used in road construction, 24 percent in the production of cement, and 13 percent in concrete production. BOF slag, which amounted to 14 million tons, was utilized to a lesser degree than BF slag, with the result that a great deal of research and development and pilot operations are being devoted to increasing its use.

Number of Steel-Making Furnaces
and Continuous-Casting Machines

Facility	Year-end 1980	Year-end 1977
Basic oxygen furnaces	94	100
Open heath furnaces	0	15
Electric furnaces	627	683
Continuous-casting machines for		
Slabs	37	34
Bloom & billets	104	96
Total	141	130

Basic Data: Japan Iron & Steel Federation

Japanese Steel Industry
Energy Consumption by Steel Industry(a)

	1973	1976	1978	1979	1980
Electric energy	17.6%	19.2%	20.5%	21.1%	19.2%
Oil-based energy	21.3	17.4	16.1	14.2	10.0
Coal-based energy	61.1	63.4	63.4	64.7	70.8
Total equivalent in terms of coal consumption (mil metric tons)	94.1	90.3	77.6	81.7	79.1
Basic data: Japan Iron & Steel Federation					
(a) Calculated in terms of coal consumption					

Energy Conservation

"The oil crisis shook the world in 1973 and severely impacted the steel industry in Japan. Since that time, as shown in the above table, the Japanese steel industry has cut its dependence on oil by more than one-half and increased its use of coal by nearly 16 percent. In 1973, oil-based energy accounted for 21.3 percent of energy but by 1980 this number had been reduced to only 10.0 percent. The coal-equivalent consumption savings have been 15 million metric tons. When correcting for production conditions, the savings during this period amounted to nearly 12 million metric tons of coal equivalent.

"The energy savings resulted from the streamlining of production processes, such as continuous casting, which can increase yields as much as 10 percent and reduce energy consumption by 200,000 kcal/ton. Discharged energy from blast furnaces and coke ovens has been recycled through equipment such as BF top-pressure turbines, boilers for waste heat recovery, and coke dry-quenching equipment. The industry has also embarked on a program of injecting less oil into blast furnaces by increasing the coke charge. The result is that 68 percent of all operating blast furnaces were termed all-coke operations at the end of 1980. This has increased the use of coke, but the rate in Japan average 450 kg/ton compared with 424 kg/ton in 1979 (in the October-to-December) period for last year it was 460 kg/ton, while the average for the U.S. in 1979 was a significantly greater 575 kg/ton.¹"

Mr. Hageman's paper also reviews other elements in the Japanese steel industry situation which bear directly upon the effectiveness of its operation, including management philosophy; continuing close labor/management

¹ Excerpted directly from pages 7, 8 and 9 of "Japanese Steel Industry: A study in Modernization and Productivity," by Robert A. Hageman, Economist, Research Department, Kidder, Peabody & Company, Inc., New York City.

NOTE: This and other material quoted herein or attributed to Mr. Hageman's paper is used with permission.

contact and sound mutual trust and confidence between labor and management; and loyalty to the firm. He also emphasized the facility enjoyed by the Japanese industry in obtaining funding for capital investment from the historically-strong Japanese propensity to save; and the handling of investment expenditures treated as tax-deductible expenses. He also mentioned long-term financial relationships with leading Japanese banks, deemed a channel distinctly preferable to equity financing as practiced in the U.S., with the normal stockholder demand for current dividends and rising stock values.

Mr. Hageman makes an observation in his concluding statement which is strongly endorsed and shared by the authors of this document and by APC Chairman C. Jackson Grayson, Jr., that a recent step by several U.S. steel-makers in signing technological assistance agreements with their Japanese counterparts for the introduction of continuous casting and other techniques is a long step in the right direction. From the point of view of the U.S. consumer as well as the Government and the steelworkers, sound actions to improve the efficiency of the U.S. steel industry are considered essential to the industry's future and the improvement of its employment potential.

CHAPTER III.

Comments and Statistical Support Data on International Productivity Dynamics and Major Causative Factors

In this section, we are presenting some analysis and selections from the excellent statistical series on the correlation of productivity growth and causative factors, as developed by John Kendrick, Angus Maddison, Vladi Catto, the APC staff, and others. Virtually all of these analyses show Japan at the "high" or "favorable" extreme, with the United States (and/or the United Kingdom as well) at the "low" or "lousy" end of the spectrum. Included in the correlation series are the following "causatives".

- o average age of machinery and equipment
- o the direction and extent of substitution of embodied capital for labor input -- or the change in the capital/labor ratio
- o average ratios of gross fixed investment to GNP
- o ratios of net savings to GNP (savings constituting perhaps the most important source for capital for investment)
- o growth rate of real national product to both labor and to total factor productivity growth
- o growth rates in R&D expenditures to improvement of productivity
- o extent of energy conservation related to labor productivity

(Certainly other "causatives" such as management styles and involvement of the Japanese worker have played a fundamentally significant role, but because of their less quantifiable nature, they are not included in this correlation series.)

A. Growth of Real National Product and Productivity Trends

Over the years, data have shown a very direct, strong and continuing relationship between productivity and output growth. Expressed in this way, we are stating almost a truism, since in most spans of time it is productivity growth (whether expressed in total factor or labor input terms) which contributes the largest proportion of the output growth, the residual being of course the relative amount of inputs of labor and of other economic factors.

There are, however, underlying factors relating to the growth rates of output and productivity which may be identified, and which explain to some degree not only the causative relationship but also the differences in growth rates at different spans of time. First, as John Kendrick and others have pointed out, productivity growth tends to be most rapid in periods of rapid rises in output, especially in relatively new industries or in newly-industrializing nations. Due to what Kendrick has labeled "economies

Table 6.

Growth in Productivity in the Business Economies of
Selected OECD Countries, 1960-1973 and 1973-1979
(average annual percentage rates of change)

Productivity Measures	(In all cases, 60-73, 1; 1973-79; 20)																	
	U.S.		Canada		Japan		U.K.		France		West Germany		Sweden		Italy		Belgium	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Real gross product per labor hour	3.1	1.1	4.2	1.0	9.9	3.8	3.8	1.9	5.9	4.2	5.8	4.3	5.8	2.5	7.8	1.6	6.1	4.4
Capital/labor substitution	1.2	0.5	1.3	1.1	3.3	2.0	1.6	1.6	2.0	2.0	2.6	2.2	2.2	2.2	2.0	0.8	1.9	1.0
Total factor productivity	1.9	0.6	2.9	-0.1	6.6	1.8	2.2	0.3	3.8	2.1	3.2	2.1	3.6	0.3	5.8	0.8	4.2	2.6
Capital productivity	-0.1	-0.2	1.1	-1.6	0.1	-2.2	0.7	-2.6	0.7	-1.1	-1.5	-1.9	1.3	-0.8	0.1	-3.3	0.9	-0.6

Basic Data: John Kendrick, op. cit, Table 7.

Source: American Productivity Center

of scale", rising growth makes possible the introduction of more and better machinery, equipment and work techniques, which in turn tends to reduce the ratio of labor input per unit of product. Further, there is in such instances a very real efficiency increase due to the basic "learning curve" as both management and labor find new, better ways to accomplish the desired output, again with reductions in labor, (and/or other input) per unit of output.

Further -- and a factor which applies on the shorter term whether output is rising or falling -- productivity growth (or the lack of it) is influenced significantly by the percentage of utilization of designed plant capacity. If utilization of plant capacity goes up, productivity tends to rise on an almost parallel path, up to a certain point, after which a reversal occurs as capacity use is pushed beyond a marginal-efficiency point. On the reverse side of the coin, when sharp drops in output lead to declines in the use of the plant's machinery and equipment, productivity must certainly slack off, as the inputs cannot be scaled down as rapidly as was output and plant utilization.

It is significant to note, however, that the relationship of changes (positive or negative) in output and in plant capacity utilization work to a differing extent as between capital productivity and labor productivity (especially direct labor) and hence between labor productivity and total factor productivity. The reason, while not always recalled, is both simple and direct:

- with losses in output, employees involved in "hands-on", (or direct labor), operations will be laid off or their hours will be cut; however,
- employees in "indirect" or "overhead" labor categories are not so readily cut back nor so readily recalled, since many of the indirect categories involve higher -- and scarcer -- skills. Hence, indirect labor productivity will slip more with drops in output than will direct labor productivity; and
- capital productivity (the relation between the physical plant and measured output) is almost fully inflexible with the possible exception of "mothballing" some of the least efficient machinery. Hence, the upward or downward movement of capital productivity tracks almost completely the movement of output and plant capacity utilization; hence,
- total factor productivity (the weighted combination of labor and capital productivity) will fall somewhere between the trends for labor and capital productivity. In a capital intensive industry (such as chemicals or petroleum), the total factor productivity trend will follow the capacity utilization trend closely. In a labor-intensive industry -- such as furniture, leather, trade or construction -- the productivity trend may be significantly different from that for capacity utilization, at least for a reasonable period of time.

As can be noted in Figure 14, the relationship of United States and Japanese real output to labor productivity growth shows an interesting pattern over most of the past century:

- o 1870-1913, the relation of output per hour to real GDP growth rate was slightly favorable to the United States;
- o during 1913-1950, a span marked by a devastating depression and a major World War (in which Japan was on the losing side), the United States productivity/output growth was well above the Japanese pace; but
- o during 1950-60 and 1960-73, Japanese growth rates in both output and labor productivity were vastly superior to those of the United States; and
- o in the post-OPEC span 1973-81, Japan retained its advantage over the United States, though both the absolute levels of growth rate and the degree of differential were less than the 23 years before the OPEC oil shock.

B. Age of Machinery and Equipment

One of the major factors contributing to Japan's effective adjustment to the OPEC energy shocks was clearly her rapid and extensive introduction of new and more energy-efficient machinery, equipment and work techniques. As will be set forth in more detail in later sections of this paper, Japan's rate of increase in fixed capital stock during the '60s and '70s was far and away more rapid than that of any other industrial nation -- triple the U.S. capital stock growth rate in 1960-73 and double the U.S. pace in 1973-80:

	<u>Average Annual growth rate in real fixed stock (percent)</u>	
	<u>1960-73</u>	<u>1973-80</u>
United States	4.1	3.5
Japan	12.2	7.0

As our later analysis of total factor, labor and capital productivity for the United States and Japan during the '70s will show, Japan's increase in capital input substantially exceeded the increase in labor input, with a sharp resultant rise in the ratio of capital to labor, accompanied by a strong rise in both total factor and labor productivity, especially in the manufacturing sector.

Japan's unfavorable capital productivity trend during 1973-80 does not, as some observers have implied, indicate Japanese mismanagement or errors in judgment. Rather, it is the result of deliberate and effective action to curtail energy consumption through the introduction of energy-efficient machinery and equipment; and to introduce other efficiency-improving processes.

The scale of this Japanese thrust for machinery/equipment substitution is reflected in her ratio of business investment to GNP, noted by John Kendrick at 36.6 percent in 1973 and 30.2 percent in 1979, compared to the U.S. ratio of 18.5 percent in 1973 and 18.2 percent in 1979. Little wonder, then, that the average age of real fixed capital stocks for Japan's private non-farm business economy was quoted at 5-1/3rd years in 1978, compared to equipment age for U.S. business at 9.83 years:

Average Age of Real Fixed Capital Stocks in the Private
Non-farm Economies of Nine Countries, 1960-1978

Year	U.S.	Japan	West Germany	France	U.K.	Italy	Canada	Sweden	Belgium
1960	11.55	10.00	8.92	12.26	12.00	10.60	12.00	10.00	12.00
1973	9.73	4.87	8.39	9.26	12.48	7.81	12.00	10.71	6.26
1978 ¹	9.83	5.33	9.07	9.00	12.74	7.89	12.33	11.17	6.09

¹ Data subsequent to 1978 are not available in this tabulation. However, APC's binary productivity comparison, set forth in this paper, shows that Japan's rate of capital stock growth in the non-farm business economy continued significantly above the U.S. pace from 1978 through 1980 -- an average annual growth rate of 6.5 percent/year compared to the U.S. pace of 3.7 percent year. Hence, it is certain that the average age of equipment differential will have widened substantially, since either replacement or addition would lower the average age of all capital stock in use.

Source: OECD, as quoted by John Kendrick in "International Comparisons of Recent Productivity Trends", in the American Enterprise Institute's "Essays in Contemporary Economic Problems: Demand, Productivity, and Population", 1981. Page 160.

C. Investment and Productivity

In subsection 3.b, immediately above, we noted the importance of Japan's high rate of investment to the improvement of her industrial plant; and its relation to average age of machinery and equipment. In general, productivity observers rank the extent and soundness of investment for new and improved plant and equipment at or near the top of the scale of factors affecting productivity growth. Similarly, all analysts dealing with international comparisons have noted the leadership of Japan over the post-war years in the pace of her application of available capital for industrial investment.

We also noted in passing in section 3.b, the relationship of new investment to efforts to overcome the adverse impact of the OPEC energy crunch -- a matter we will return to later. In this section, we propose mainly to present specific data on relative amounts of capital formation as between the major industrial nations, and to relate the investment rates to comparative growth rates for productivity.

There are a number of various "investment rate" bases which writers have used, including gross fixed capital formation; non-residential fixed investment; private business investment; and the percent of fixed capital formation contributed by the national government. Of all these, the best series for comparison with trends in productivity for the private business sector is probably the relative private business investment. Unfortunately, however, such data are not so readily available over a span of time as are other series, which are almost-equally useful. (Also, purely "private" business investment totals may be improper for international comparisons, due to the difference between nations in the extent of government ownership of and current investment in industrial facilities. For countries such as Sweden or the United Kingdom, for example, an aggregate of private plus Government investment is a requisite for comparability).

Hence, in this instance we have used OECD data on gross fixed capital formation as a percent of GDP, which we have expressed in terms of average percentage per year for the spans 1960-73 and 1973-80. Matched against these ratios are Angus Maddison's figures on real GDP per hour for the same time spans. In productivity growth rates, Japan is by far the highest in period 1, and tied with Germany for the high in the post-OPEC span. Germany, France and Italy trail somewhat in both periods, with the United States, United Kingdom and Canada far below, with the poorest productivity growth rates.

In the fixed capital formation average, Japan is again far higher than the other major industrial nations, with an annual average percentage over 32 percent of GDP. Germany, France and Canada follow. United States and the United Kingdom compete closely for the lowest rate.

The correlations are obviously strong, though with some deviation from the visually-fitted trend lines, due most likely to the extremely-poor extent to which the United States, Canada and the United Kingdom adjusted to the effects of the energy crunch in the post-OPEC span. (Figure 15).

A new GAO report to the Chairman of the Joint Economic Committee, "Industrial Policy: Japan's Flexible Approach" (June, 1982), sheds useful additional light on the Japanese experience in assuring ample funding for investment and channeling it into rapid industrial development, in a context shaped to assure increasing striking power in the world marketplace, upon which Japan's economy is highly dependent (as are those of Switzerland, France, West Germany and other European nations). The GAO report includes in its digest of findings, the following:

"... following World War II and the Occupation, Japan undertook restructuring of its economy by encouraging and facilitating investment in industries considered basic to an industrialized economy. During most of the post World War II period, interest rates were kept artificially low, so demand for loanable funds exceeded supply. The government rationed available funds through direct lending from Japan's central bank to the city banks and, in turn, to companies in order to encourage, or conversely discourage, investments in certain designated industries. Thus, steel, autos, and shipbuilding in the 1950's and 1960's and electronics and machinery in the 1970's received funds while service industries did not.

"Japan succeeded through the early postwar period in marshalling an impressive array of industrial policy instruments to foster investment-led growth. Through the mid-1960's, the most powerful of these were controls imposed on economic activity through the Foreign Exchange and Foreign Trade Control law . . . significant financial support for industrial development coupled with extensive controls over trade and capital flows characterize the foundation upon which Japan grew to be an economic power."

D. Savings and Productivity Growth

Obviously, funding for investment in industrial plant, machinery and equipment must come from somewhere -- and the main source is from current savings -- by the Government and individuals. John Kendrick and others have identified a significant positive correlation between rates of growth of industrial capital stocks and the percentages of the nation's gross domestic product which is allocated to savings and investment.

It will be noted in Figure 16 that there are surprisingly-large inter-country variations in the savings ratio as a percentage of gross domestic product, which in OECD tables ranged from a high of 39.2 for Japan in 1973 to a low of 15.4 for the United Kingdom in 1975. In terms of annual averages of the savings ratio computed by the APC, there were comparable spreads: in 1960-73, a high average of 35.5 for Japan to 19.4 for the United States and 19.1 for the United Kingdom; and in the 1973-80 span, 33.3 for Japan down to 18.5 for the United Kingdom and 19.0 for the United States (Figure 16).

This strong propensity to save on the part of the Japanese nation and its citizens has been emphasized by virtually all students of international economics; and is always emphasized as one of the elements contributing to Japan's rapid post-War productivity and output growth. The new GAO report to the Chairman of the Joint Economic Committee, noted above, provides some clarification on the methods of channeling the personal savings of Japan's citizens into directed investment for the improvement of production efficiency and volume in targeted industries:

"Significant amounts of personal savings have been deposited in savings accounts operated through Japan's post offices, referred to as the postal savings system. The government, through the Fiscal Investment and Loan Program, Japan's 'second budget', directs the postal savings and pension systems to financial intermediaries, such as the Japan Development Bank, which make loans to targeted industries. These loans have served as a signal to the private financial sector, which in turn has channeled personal and corporate savings into these same industrial sectors".

Observers have also emphasized the virtual certainty that the Japanese industrial leaders' propensity to plan business operations on a long-term gain and market share basis is made possible by the fact that the lending banks are willing to go along with long range growth targeting -- a willingness certainly founded at least in part on the fact that the

funds the banks provide are in large part specifically earmarked for the improvement of efficiency and expansion of output for the targeted industries which are their clients.

In the United States, on the other hand, CEO's and other industrial leaders are, by and large, forced to focus primarily upon bottom-line current-year profits, which may be distributed that year to stockholders in the form of dividends, rather than held as funding reserved for R & D and scheduled machinery purchases needed to assure future-year productivity improvements.

E. Substitution of Embodied Capital for Labor Input (Change in the Capital/Labor Ratio)

One of the few "facts" in the composite of influences determining productivity growth -- or slumps -- on which virtually all productivity economists agree is that, other things equal, "the growth of real capital per unit of labor input increases output per unit of labor."¹ In his presentation of productivity trends and factors influencing them for nine OECD countries (quoted freely elsewhere in this APC binary comparison) Kendrick states the case on capital/labor substitution during the spans 1960-73 and 1973-79 so excellently that we feel APC can do no better than cite here direct quotes from his presentation: "Holding other things equal, the growth of real capital per unit of labor input increases output per unit of labor. According to production function theory, the rate of growth of the capital/labor ratio weighted by the capital share of factor costs (which we call "capital/labor substitution") indicates its contribution to the growth of labor productivity capital/labor substitution in the nine countries is also the reconciliation item between the growth rates of labor productivity and total factor productivity, which is the ratio of real product to a weighted average of labor and capital inputs.

"In the period 1960-1973, capital/labor substitution accounted for an average of 34.5 percent of the increase of labor productivity in the nine countries (with an average deviation of 4.5 percentage points). A simple regression between rates of change in labor productivity and in the capital/labor ratio yields R^2 with a value of .823; the equation indicates that a 1 percent increase in the ratio is associated with a 0.88 percent increase in real product per unit of labor input." (See Figure 17).

"The capital/labor ratio is positively correlated with some other variables promoting productivity growth. In particular, outlays for research and development and the pace of technological progress are related to tangible capital formation. R & D help increase the marginal efficiency of new investments, and the economic climate that is favorable to capital formation in turn tends to promote R & D and innovation. Also, since new plants and equipment are the carriers of much

1 Kendrick, "International Comparisons of Recent Productivity Trends", on page 139 of AEI's "Essays in Contemporary Economic Problems", 1981. (with permission).

technological progress, higher rates of replacement and expansion are generally associated with faster rates of advance in cost-reducing technology".

"Increases in capital/labor ratios and advancing technology also (frequently) are associated with some of the other changes that promote productivity . . . (such as) an upgrading of the skills and educational levels of the labor force and shifts of resources toward industries with above-average rates of factor remuneration. Also, periods of strong capital formation and rapid technological advance generally provide greater opportunities for economies of scale and higher rates of utilization of capacity than prevail in less buoyant periods.

"In the second period, 1973-1979, capital/labor substitution accounted for a higher average proportion of the rates of change in labor productivity -- about 72 percent -- than in the first period, but with a higher average deviation of about eighteen points. This increase in relative importance reflected significant declines in the effects of productivity growth of most of the other causal forces.

"The rate of increase in real capital stocks declined between the two periods in all countries except Canada. Even in Canada the small acceleration in capital growth was less than the acceleration in growth of labor input, so that capital/labor substitution declined. In the United Kingdom and France the deceleration of capital growth equaled the slowing in growth of labor input. In the other five countries there was a decline in capital/labor substitution, which accounted for about one-fifth of the slowing in growth of labor productivity."

F. Research, Development and the Diffusion of Innovation Contribute to Productivity Growth:

Virtually all observers of the productivity scene state that R&D and the diffusion of the innovations shaped as its result constitute a prime contributor to the growth of productivity -- and with it, of real national product per capita. In any advanced country, innovation and development are a product of both major R&D programs in Government and private-sector laboratories and lone-wolf innovation by individual inventors and the managers and staff of small business enterprises. Some observers claim that the small business enterprises and the individual inventors make the major contribution -- and certainly this was true in past decades. Other observers, however, state that the innovations developed by teams of laboratory scientists and engineers predominate in the industrial nations at the present time. In any event, there is ample documentation to support the basic thesis that innovation and its effective dissemination lie at the heart of technological progress and productivity growth.

Over the years, the United States, the U.S.S.R., West Germany, France, the United Kingdom and more recently, Japan were the leaders in devotion of their national resources to R&D, including both basic and applied research and developmental activity. Russia, West Germany and Japan have been increasing their application of resources to R&D rapidly during the past two decades. The U.S. expenditure pace, in contrast, has been dropping sharply

since the mid-1960's -- especially the Government's percentage of the total expenditure. Figure 18 showing constant-price (1973 base) trends in R&D expenditures for the United States, Japan, and Germany, provides an interesting and dramatic picture of these trends during the decade 1967-76. (This series shaped by Robert Dunn in the National Planning Committee's "Economic Growth Among Industrialized Countries", Washington, DC 1980 credits material presented in the OECD Observer, March 1979). In his extremely-effective publication, Mr. Dunn observes that R&D should be considered by both industrial firms and the national Government as a form of investment which, if effectively applied and attended by good fortune, yields technological breakthroughs and strong improvements in productivity and profits.

Mr. Dunn points out further, that "Another advantage in R&D investments is that technological knowledge is a kind of intangible capital which can be used over and over at no additional cost. Once the investment is made and a new product or process is successfully developed, little or no further R&D investment is needed no matter how often the process is used or how many units of the new product are produced."

An extremely significant fact in any analysis of the relationship of national trends in productivity and the pattern of R&D expenditures is the fact that in terms of civilian R&D (excluding military/defense/space end-use expenditures) "West Germany and Japan have had the highest ratios (of civilian R&D to GNP) over the past two decades and have generally maintained civilian R&D growth patterns at a faster rate than their national economies were growing These trends in civilian R&D in Japan and West Germany seem to parallel their productivity growth rates and R&D-intensive trade performance." ¹The Science Board analysis went on to emphasize that whereas U.S. Government-funded R&D has focused primarily on defense and space programs, "a large percentage of Government R&D funds in these two countries (Japan and West Germany) are devoted to energy production and to areas of economic development, including manufacturing, mining, telecommunications, agriculture, forestry and fishing." Obviously, such focus on productive aspects of the economy in the thrust of Government-financed R&D must inevitably exert an effect on the pace of industrial innovation and of productivity growth in the national economies contributing to the observed differential productivity rates for the U.S., Germany and Japan.

This pattern of trends in civilian R&D during the past two decades is clearly shown in Figure 19, derived from the Science Board document cited. While there has been some increase in the United States ratio of civilian R&D to GNP, it has been overshadowed by the spectacular surges in that percentage for West Germany and Japan -- a fact which is not coincidental to their truly-astounding productivity growth rates during the same time-span.

In addition, informed observers (specifically including several writers in the Japanese press) have pointed out that Japan, which depended primarily

1 "Science Indicators 1980", the National Science Board, National Science Foundation, Washington, DC 1981, page 9.

upon "imported innovation" for a decade or more after World War II -- adapting those innovations to the particular requirements of Japan -- is currently devoting increased efforts to basic as well as applied R&D. From available information, Japan is now concentrating basic R&D efforts in the high-technology area, including computers, semi-conductors, high-capacity silicon chips, and other information technology/communications applications, and on robotics for industrial applications. Such efforts, seen in context of past Japanese successes in shaping effective new industrial methods and technology, appear certain to influence future productivity growth as well as international product marketing patterns to a significant degree.

A clear indication of Japan's growing interest and activity in expanding R&D and participating in world leadership in innovation lies in the statistics on action by Japanese in patenting in the U.S. their own inventions:

	U.S. patents granted to foreign inventors					
	1966	1970	1973	1977	1978	1979
Number	13,771	17,354	22,639	23,785	24,846	18,783
Percent of total						
U.S. Patents:	25.2	26.9	44.0	57.3	60.3	62.5
Percent granted						
to Japanese:	2.0	5.6	9.6	15.0	16.8	17.5
Percent Japanese						
of total foreign						
grants:	8.1	15.1	21.8	26.1	27.8	28.0

Source: APC Basic Data, "Science Indicators 1980", p. 255

Most observers agree that the Governments of Japan, as well as of France and West Germany, have supported and worked more closely with the private business community in shaping sound R&D and the dissemination of results than has the United States -- specifically including low-cost multiple licensing for production of the innovations stemming from Government-subsidized R&D. A document of particular interest in this respect is "Technology Enhancement Programs in Five Foreign Countries", prepared under the direction of John A. Birch and George C. Nichols, U.S. Department of Commerce, December 1972 (NTIS document COM-72-11412).

The useful new GAO report, "Industrial Policy: Japan's Flexible Approach", referred to above, provides less-detailed but more up-to-date information on the inter-action of the Japanese Government and its industries in the shaping and diffusion of new technology. It states, for example, "Direct subsidies to joint government-industry research and development programs are widely used instruments of government assistance for technology development, as are tax and leasing programs for technology diffusion. These mechanisms work through incentive rather than control . . . Today the emphasis of government support has shifted from heavy industries to sophisticated technology targets; industries are assisted in developing and diffusing,

throughout the economy, technologies that contribute to high value added; productivity, and resource conservation. These include the computer, robotics and aircraft industries among others. Industrial policies for growing industries are implemented after extensive discussions between the government and groups representing industry and other interests".

To the extent that sound new innovations are in fact diffused more rapidly throughout the industrial community, the broadened application of new product designs, machinery, equipment and techniques inevitably contribute to the acceleration of productivity growth.

G. Energy and Productivity Growth

Since the invention of the steam engine by James Watt and the resultant industrial revolution, with attendant growth of factory-type industry and large-scale transportation and distribution of the products, industrial production growth has been based firmly upon the availability of reliable sources of reasonably priced fuels and energy. From the wood and coal-burning steam industrial power plants, through the petroleum derivative-powered internal combustion engines and finally the individual electric motor drive, machinery and equipment manufacturers have steadily developed and marketed products which provide greater outputs with less input of human effort.

Entirely-new services and time/place utilities also have been provided. These range from the first high-stacked wood-burning steam locomotive, forward through huge distance-devouring coal-burning Magnum locomotives; and increasingly-efficient steamships. More recently, even these in turn were largely replaced by diesel ship and railroad engines; by cars and trucks traveling at increasing speeds over improving highways; and finally by airplanes transporting goods and people at sub-sonic and super-sonic speeds and by nuclear-powered ships and power plants. (Space travel, laser transmission of power and messages and other earlier unheard-of-devices appear on the horizon).

As a direct result of increasingly-efficient power sources, output volume in the industrial world has grown at an almost algebraic pace, along with productivity. Profits have increased; wages and the standard of living have risen steadily; and prices to the consumer have been steadily lowered -- with interruptions only in times of war -- and a much greater variety of products made available.

Hence, over the years, the input of increasing amounts of energy has been a truly-major contributor to productivity growth. In the past, however, the energy input has tended to be taken for granted; and econometricians and other analysts have given credit to machinery and equipment and other forms of "embodied capital" as the primary source of productivity growth.

The Organization of Petroleum Exporting Countries 1973 embargo on shipments of petroleum and the subsequent four or five-fold escalation of crude oil prices put an end to both the era of cheap energy and the too-general tendency to assume its continuing availability and ignore its true contribution to human welfare.

As noted earlier, a substantial amount of the industrial world's most energy-intensive machinery and equipment was abruptly made unusable economically. The focus of Governments and of the private industrial community shifted to often-frantic actions to conserve energy (particularly petroleum derivatives); and to find new ways of doing things with lowered inputs of energy per unit of product.

The combined impact of escalated prices and overly-limited supplies of energy forced the world into a recession in 1974-75 which proved the most severe since the Great Depression of the '30s. We noted earlier that, as the industrial world scrambled to recover in the late '70s, it was confronted with a second "oil price shock" in 1979-80, with another quadrupling of already high oil prices, triggered this time by the Iranian conflagration. Again, the direct result was the double-dip recession of 1980-81, which still holds the industrial nations in its grip.

During the early years of the post-OPEC energy crisis, a goodly number of the leading economists accorded only a minor part of the productivity slowdown to the energy problem, citing instead a number of other "probable causes of the slowdown." Frequently cited were inter-sectoral shifts in employment, dilution of the skills and efficiency of the labor force, Government regulations, and a large percentage attributed to Denison's "residual", which other economists have referred to the "measure of our ignorance" concerning factors affecting productivity.

More recently, however, as both the direct and the secondary impacts of the energy crunch have become increasingly obvious, some leading economists -- especially Dale Jorgenson and John Kendrick -- are according a major role for energy problems as the culprit responsible for the productivity growth slackening -- even though they have not as yet been altogether successful in shaping a computer program for their macro-economic models to place a specific quantitative value on both the direct and the indirect effects.

Most significant from the productivity perspective is that in the United States and some other industrial nations, the century-long tradoff of energy-driven machinery and equipment for human labor was abruptly reversed, due to the combined impact of mandated cutbacks on energy use; quantum leaps in its prices (nearly ten-fold); and the escalation of both machinery prices and interest rates on the capital required to buy it. A contributing factor to the deferral of planned introduction of new machinery was also uncertainty as to possible future Government controls on energy usage, plus the hope that more energy-efficient models would be developed for early availability.

There is clear evidence of this reversal. In almost all the major industrial nations except Japan, a slackening of new capital investment was accompanied by a sharp rise in labor inputs after 1977 or 1978. In the United States, for example, average hours per employee had been declining roughly 1/2 of 1 percent per year; but in 1979, this average rose sharply and remained higher in 1980. In terms of aggregate labor input for the private business economy (which reflects both growth in employment plus average hours per worker) there was a rise of 5 percent in 1978; over 3 percent in 1979; and only a fractional drop in 1980, as total output fell over 1 percent. In Japan, however, labor input after 1977 rose only about 1 percent per year, as

output was rising strongly: 5.7 percent in 1978; nearly 7 percent in 1979; and over 6 percent in 1980.

For Japan, the input of capital per unit of output rose strongly in the business economy and in most of the sectors and industries after the 1974-75 recession. The rise reflected vigorous efforts to improve the efficiency of production operations, with strong emphasis upon increasing energy productivity and curtailing its use.

As a result, Japanese labor productivity rose strongly in the later years in the decade, total factor productivity rose almost 3 percent per year. Profitability rose vigorously along with increased shares of the world market for manufactured goods. Capital productivity fell fractionally between 1977 and 1980, as capital input slightly exceeded total output.

We are presenting some recently-compiled statistical data comparing both levels and trends in energy productivity for the major industrial nations to both labor and total factor productivity. Figure 20 presents two sets of data which relate energy productivity to labor and total factor productivity:

1. Relative levels of energy productivity, 1973 and 1978, for seven nations, with the United States level as 100. ("Energy productivity"), as computed by the American Productivity Center and presented in its "Benchmark 7", relates total energy usage (in barrels of oil equivalent) to constant (1979\$) GNP. Unfortunately, the data on total energy usage terminates in 1978. This comparison tends to understate Japan's current energy productivity advantage, since the energy performance of Japan in 1979 and 1980 was apparently stronger than for almost any other major nation, and
2. Energy productivity growth rates, 1973-78, compared to a) labor productivity/trend for the economies (real GDP per hour, in constant 1970 dollars matched against aggregate hours worked); and, b) total factor productivity trends for private business, for the same nations.

The correlation figure for the growth rate of energy productivity related to both labor productivity (for the economy) and total factor productivity for the private business community show a clear pattern of favorable experience for Japan, Germany and France, contrasted to the poor or relatively-poor experience of Canada, the United States, the United Kingdom and Italy.

The evidence of these comparisons is indeed conclusive. It will be noted that only Canada recorded a lower "energy productivity" level than did the United States in both 1973 and 1978, with Germany, Japan and France at levels twice or more that of the United States. Further (and a cause for continuing concern by U.S. policy-makers), the relative advantage for these three nations, plus Italy and even the United Kingdom, was significantly larger in 1978 than in 1973.

Japan improved her energy productivity even more in 1979 and 1980, attendant upon very heavy gross fixed capital inputs in these years as revealed in APC's new total factor productivity binary. Indexes of capital

input (in the private business economy) by Japan and the United States, with the 1977 level as 100, reveal that Japan's fixed capital input pace was nearly double that of the United States during 1977-1980:

Index of gross fixed capital input (77 equals 100)

	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
United States	100.0	103.9	108.0	111.6
Japan	100.0	106.0	113.0	120.5

In his recent international productivity analysis published by the American Enterprise Institute, John Kendrick offered some useful figures on average annual changes in output; energy consumption; and also on energy input per unit of total factor input, labor input, capital input and per unit of real product. (The latter figure is the reciprocal of a growth rate for "energy productivity"). This comparison, which we limit herein to Japan and the United States, shows clearly the tremendous effectiveness of Japan's efforts to reduce energy consumption and improve the efficiency of its use: whereas Japan's real output dropped from its amazing growth rate of 10.8 percent per year in 1960-73 to a still-strong rate of 4.2 percent per year in 1973-79 (about 60 percent), total energy consumption dropped from 11.1 percent per year to 0.2 percent per year -- a full 98 percent. The results show up clearly in Japan's real product growth rate of 4 percent per year in 1973-79, contrasted to the United States rate of 2.9 percent per year.

	<u>Average Annual Percent Change In</u>					
	<u>Real Product</u>	<u>Total Energy Consumption</u>	<u>Energy Input Per Unit Of:</u>			
			<u>Real Prod.</u>	<u>Total Factor</u>	<u>Capital Input</u>	<u>Labor Input</u>
<u>1960-73:</u>						
U.S.	4.4	4.2	0.2	1.7	-0.3	2.9
Japan	10.8	11.1	0.3	6.9	0.2	10.2
<u>1973-79:</u>						
U.S.	2.9	0	-2.9	-2.3	-3.0	-1.7
Japan	4.2	0.2	-4.0	-2.2	-6.2	-0.2

In its useful "Benchmark 7" on energy productivity, the APC noted that five major manufacturing industry groups in the United States (chemicals; primary metals; paper; petroleum and coal products; and stone, clay and glass) account for 72.5 percent of total energy use in manufacturing, according to the 1977 Census of Manufacturers (the most recent full Census available). However, as the Benchmark noted, these industries contribute only 26 percent of total manufacturing value added.

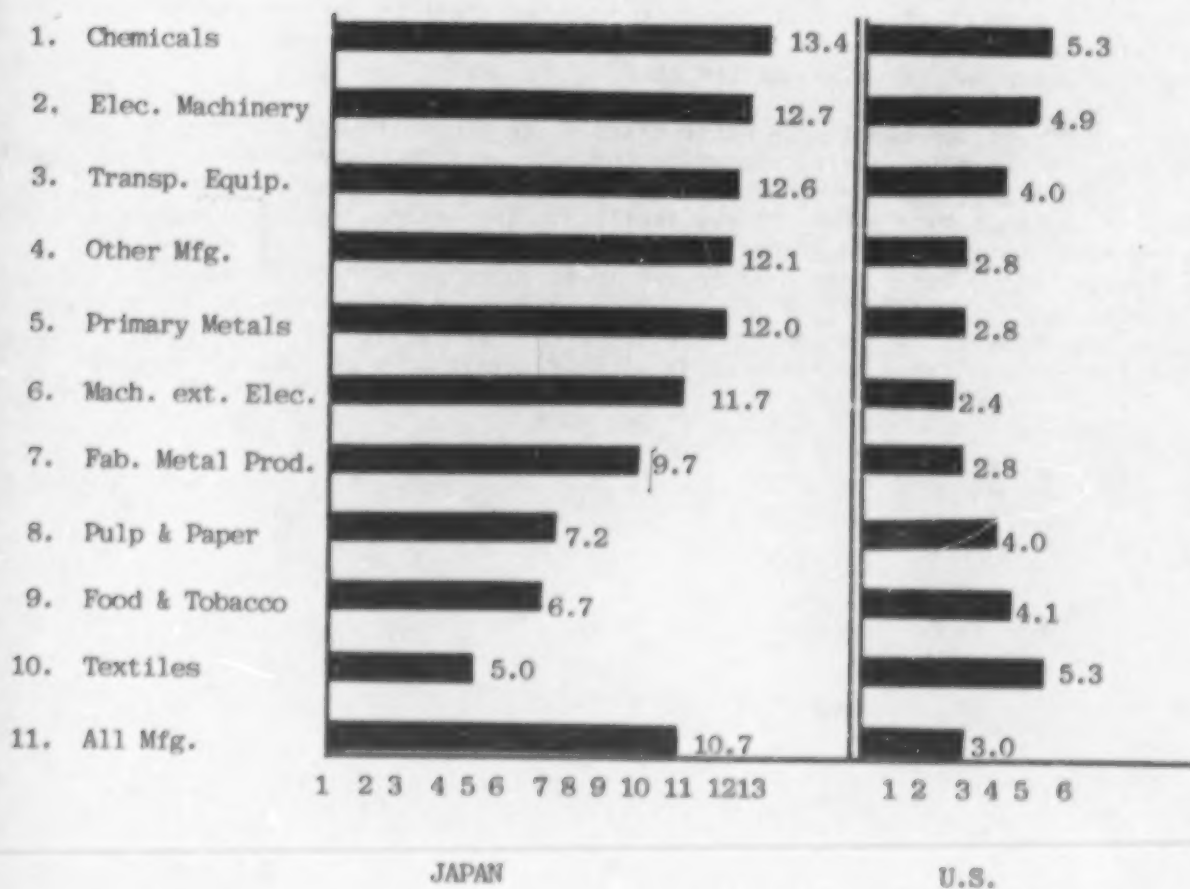
Further, in a sub-analysis of manufacturing industry energy productivity, the primary metals group was identified by APC as having experienced a significant average decline in energy use efficiency, in contrast to the more favorable experience recorded for each of the other four noted major industries. The steel industry constitutes a major segment of the total

primary metals group in terms of both employment and output (two-thirds, more or less); and presently shares with the automobile industry the dubious distinction of the most severe unemployment rates and international market competition problems of any major U.S. industry. Hence, this is an area for particular consideration.

The energy performance of Japan's steel industry was as spectacular as its pace of technological improvement -- as covered in some detail in Chapter II. During the post-OPEC span 1973-80, Japan's steel industry energy consumption (total, all types) declined 16 percent, while steel output dropped 6.5 percent during the same period. Expressed another way (tons of raw steel produced per unit of energy consumed) energy productivity increased nearly 11.1 percent from 1973 to 1980, an average of 1.5 percent per year. This is indeed a sharp contrast to the United States steel industry's energy productivity performance over most of the post-OPEC span -- an average decline of 1.5 percent per year, on the basis of APC calculations.

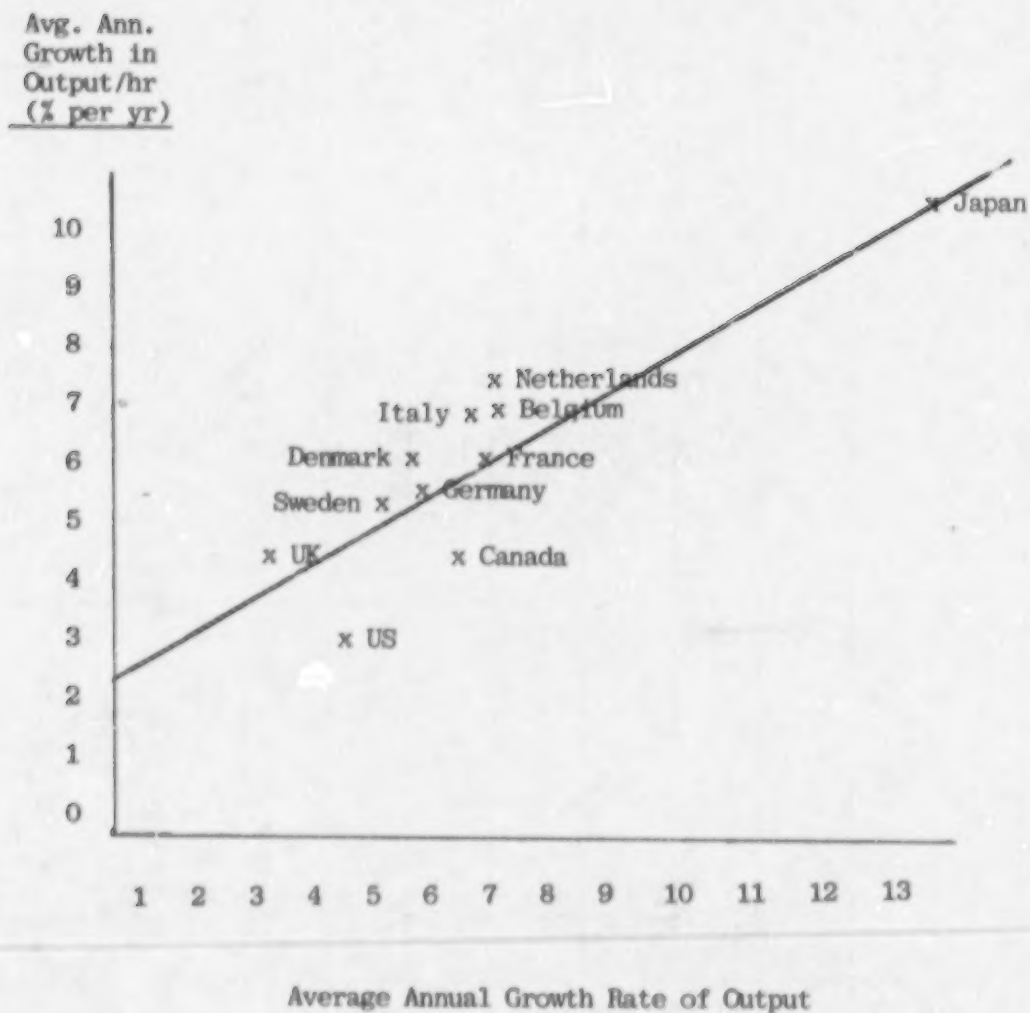
While Japan is dependent upon other nations for virtually all of its fuel/energy requirements, during the years following the OPEC shock crude petroleum rather than coal or other fuel/energy sources was the major problem, in terms of both price and availability. The Japanese steelmakers displayed their versatility and competence by cutting their use of oil-based energy consumption by more than half in the seven years post-OPEC -- from a "coal equivalent" of 21.3 million to only 10.0 million metric tons -- a reduction amounting to an average of over 10 percent per year. This is truly a target for United States steelmakers to study closely and work toward.

Figure 1.
Comparative Growth Rates in Labor
Productivity, U.S. and Japan, 1960-
73. Manufacturing Industry Groups.



Source: American Productivity Center

Figure 2.
Average Annual Growth Rates of Manufacturing
Labor Productivity Related to Output Growth
Rates, Major Industrial Nations, 1960-73.



Source: American Productivity Center

Figure 3. Productivity Dynamics in the Seventies,
Private Business Economy,
U.S. and Japan

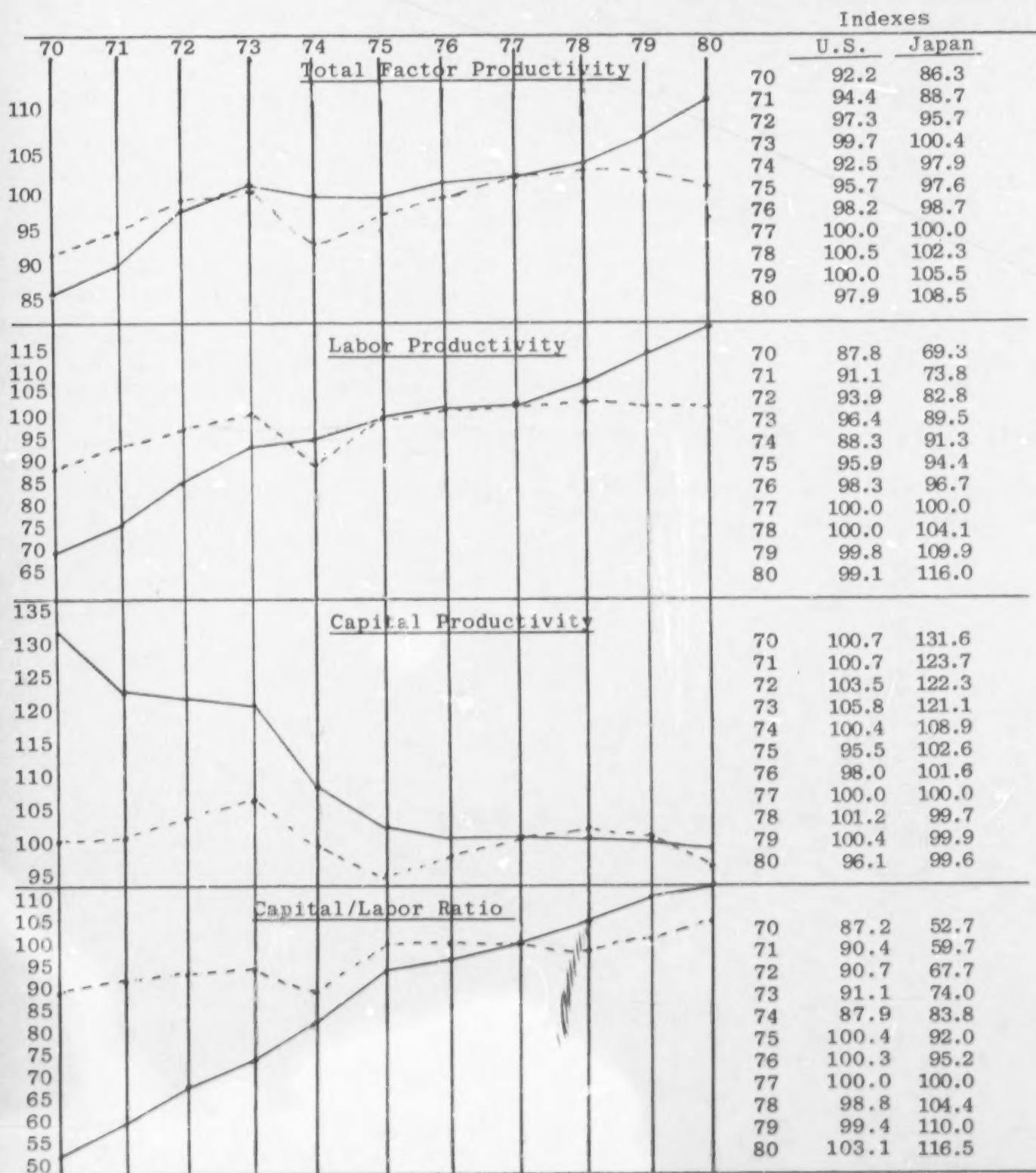
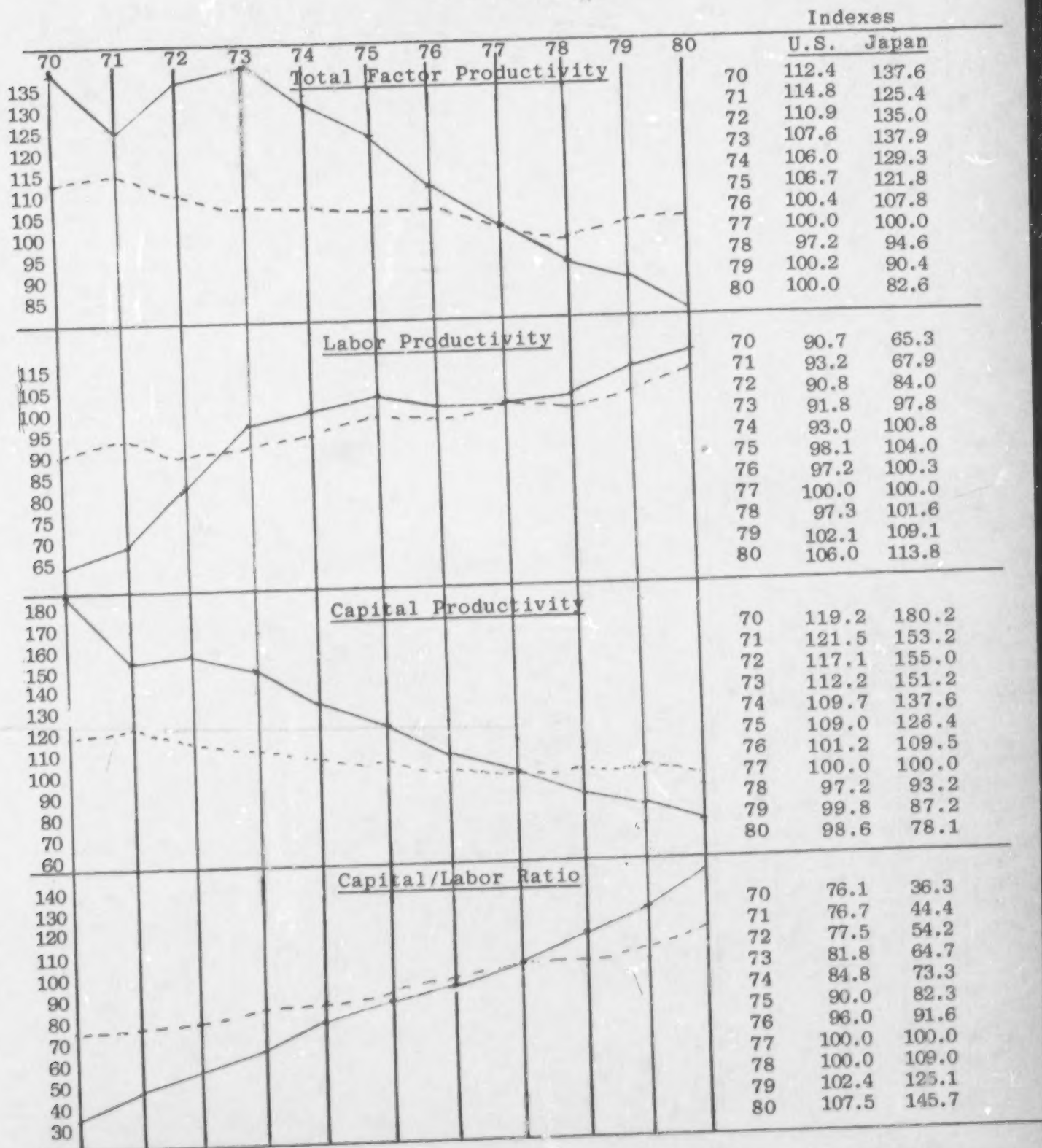
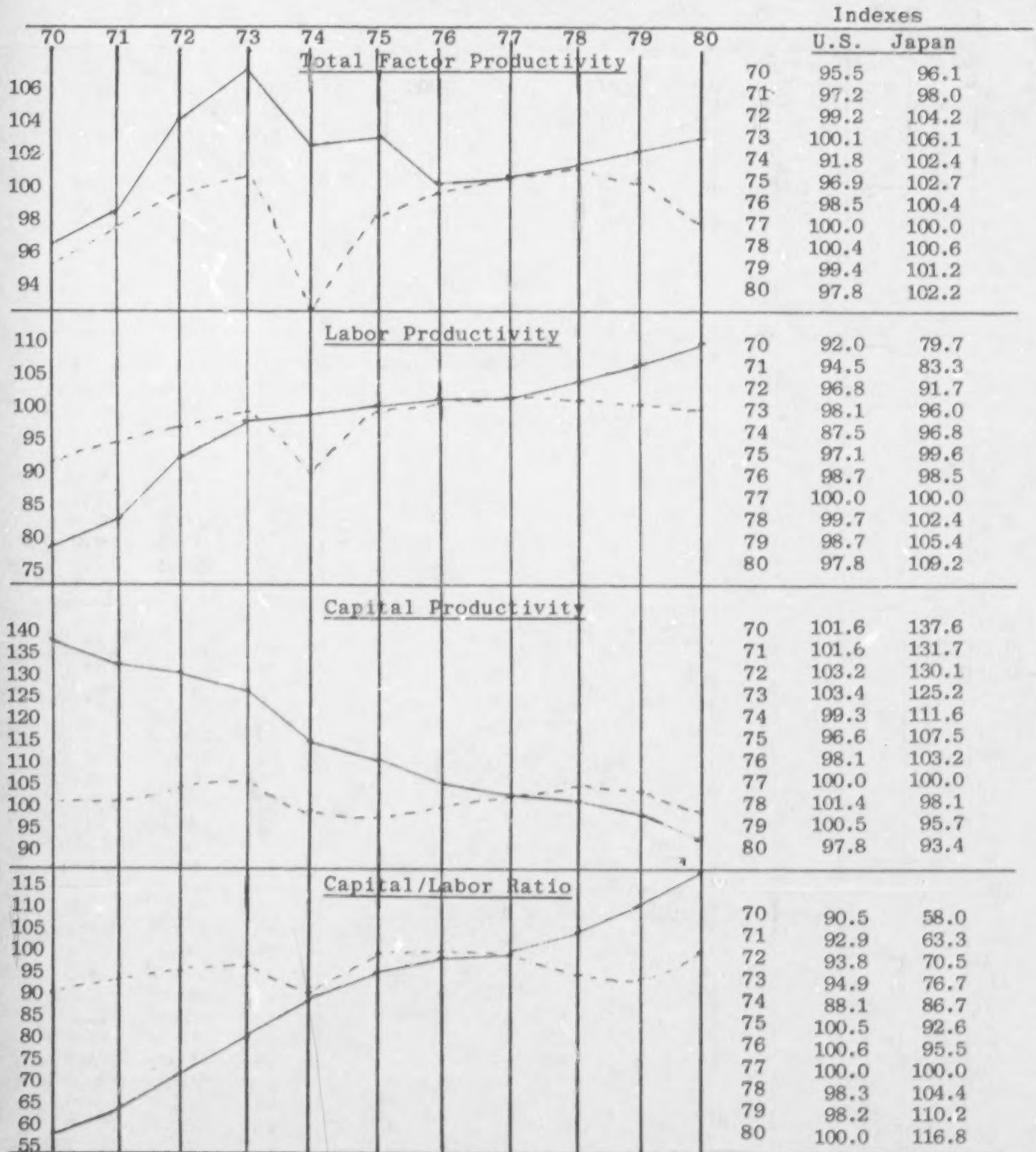


Figure 4. Productivity Dynamics in the Seventies,
Agricultural Industry
U.S. and Japan



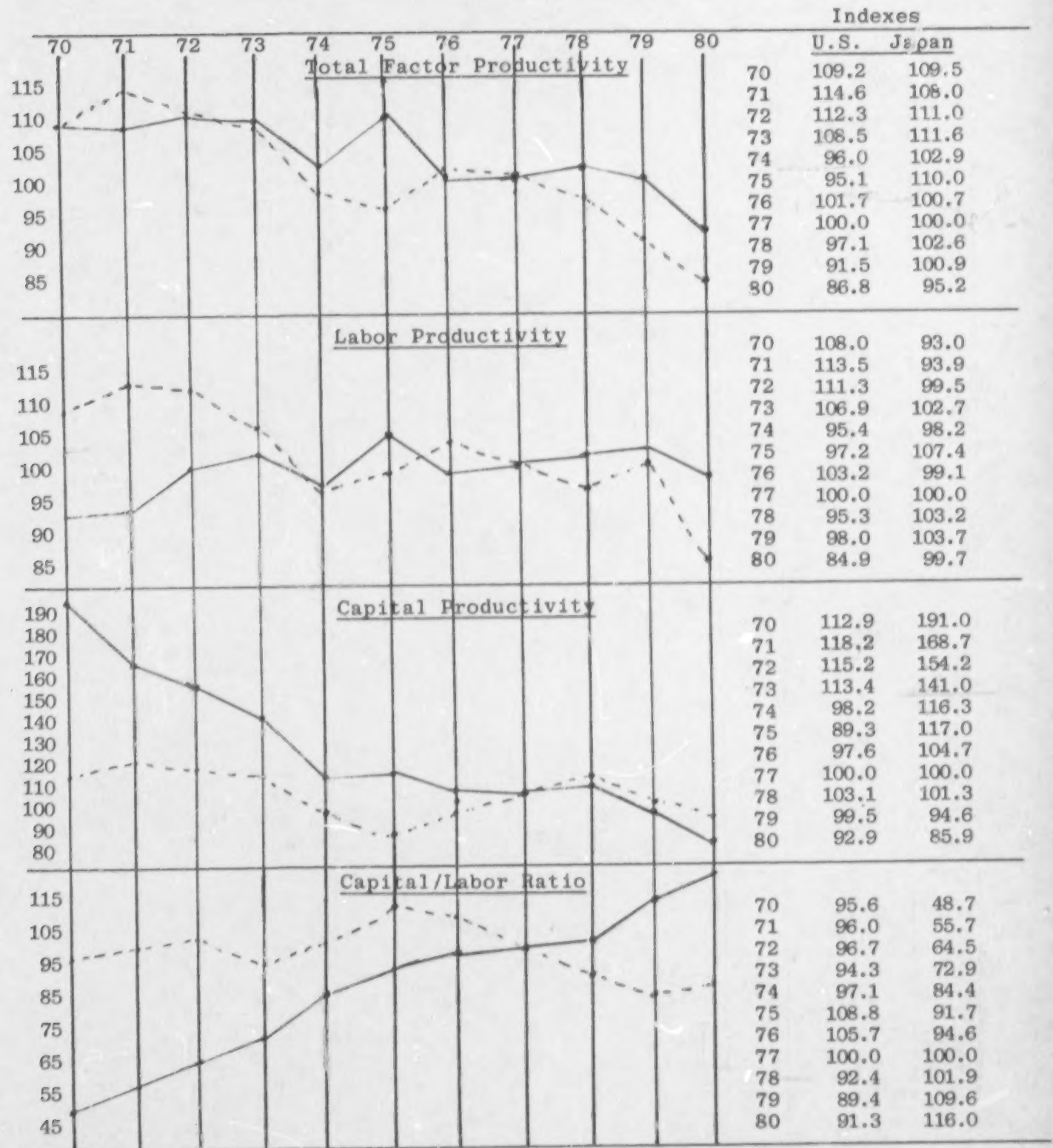
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Figure 5. Productivity Dynamics in the Seventies,
NonFarm, NonManufacturing Industry
U.S. and Japan



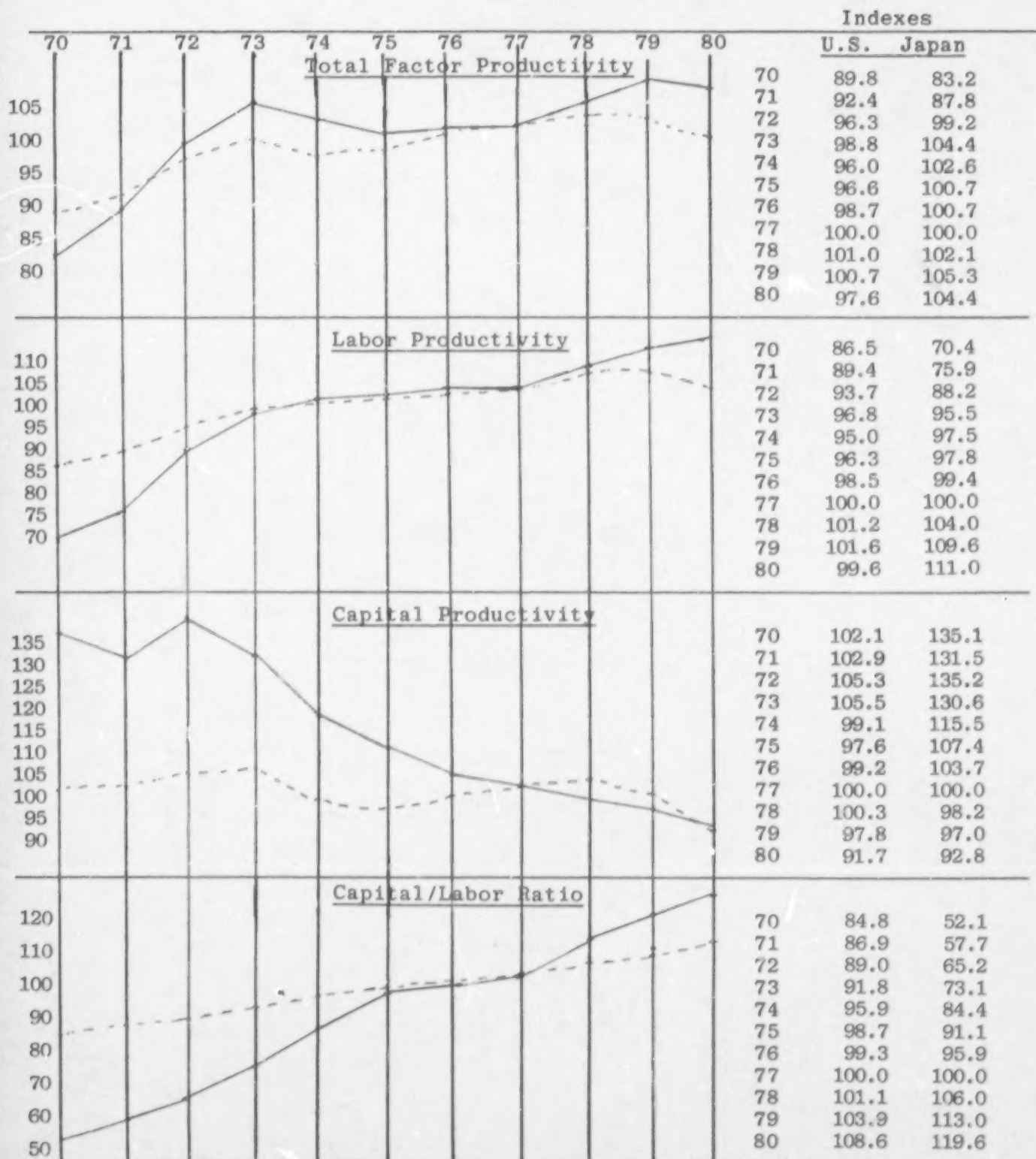
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Figure 6. Productivity Dynamics in the Seventies,
Construction Industry
U.S. and Japan



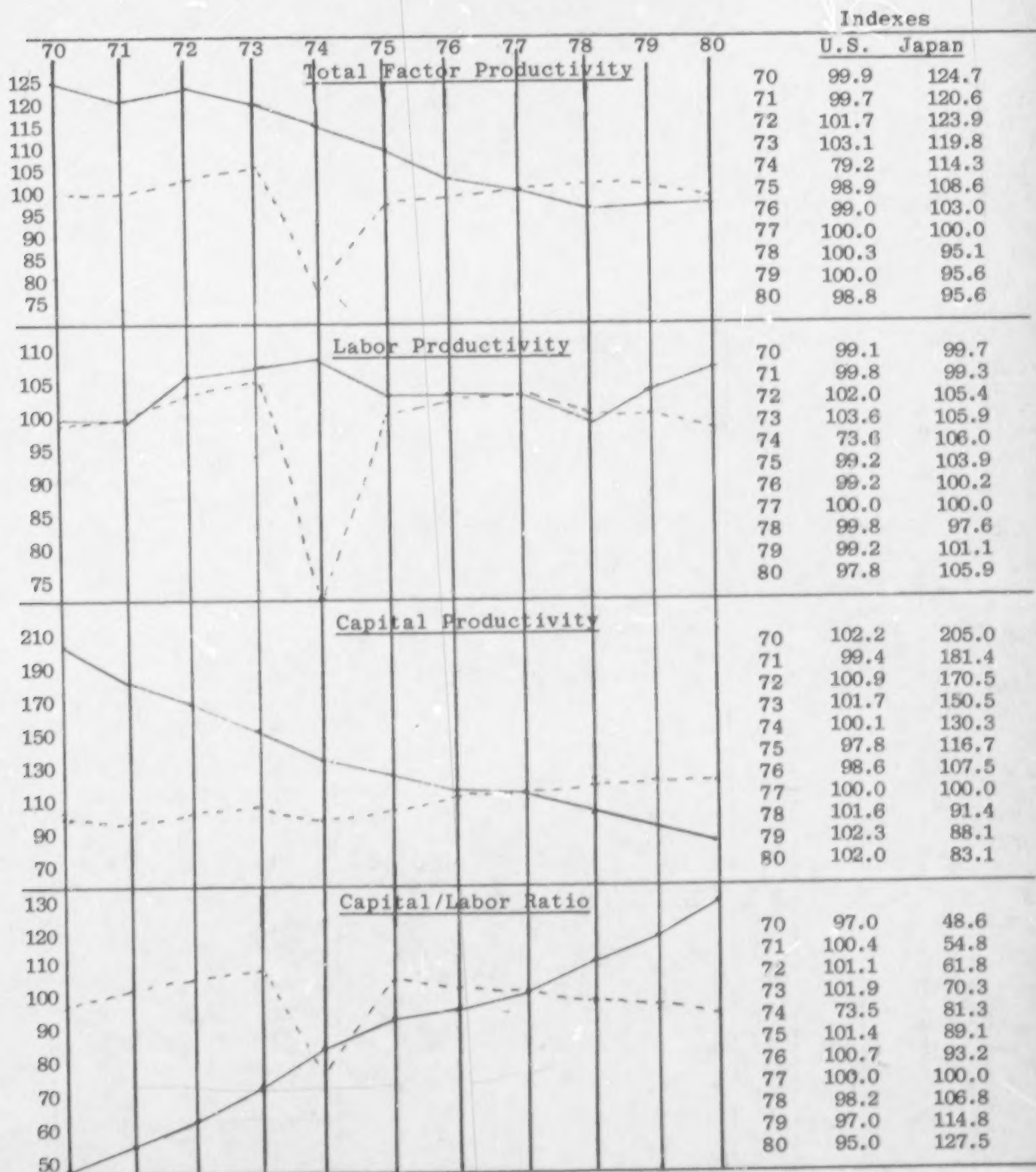
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Figure 7. Productivity Dynamics in the Seventies,
Trade Industry
U.S. and Japan



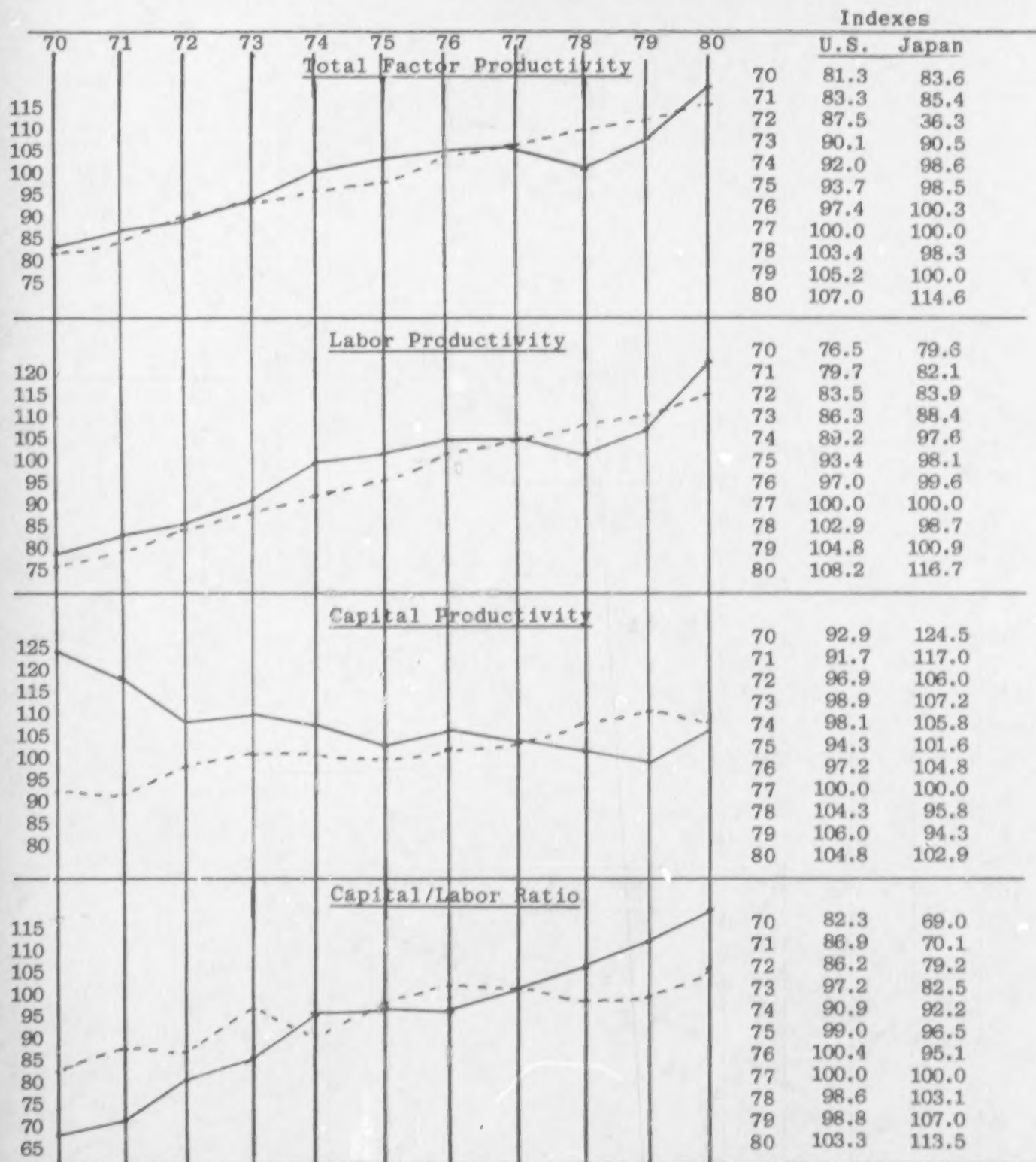
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Figure 8. Productivity Dynamics in the Seventies,
Business & Professional Services
U.S. and Japan



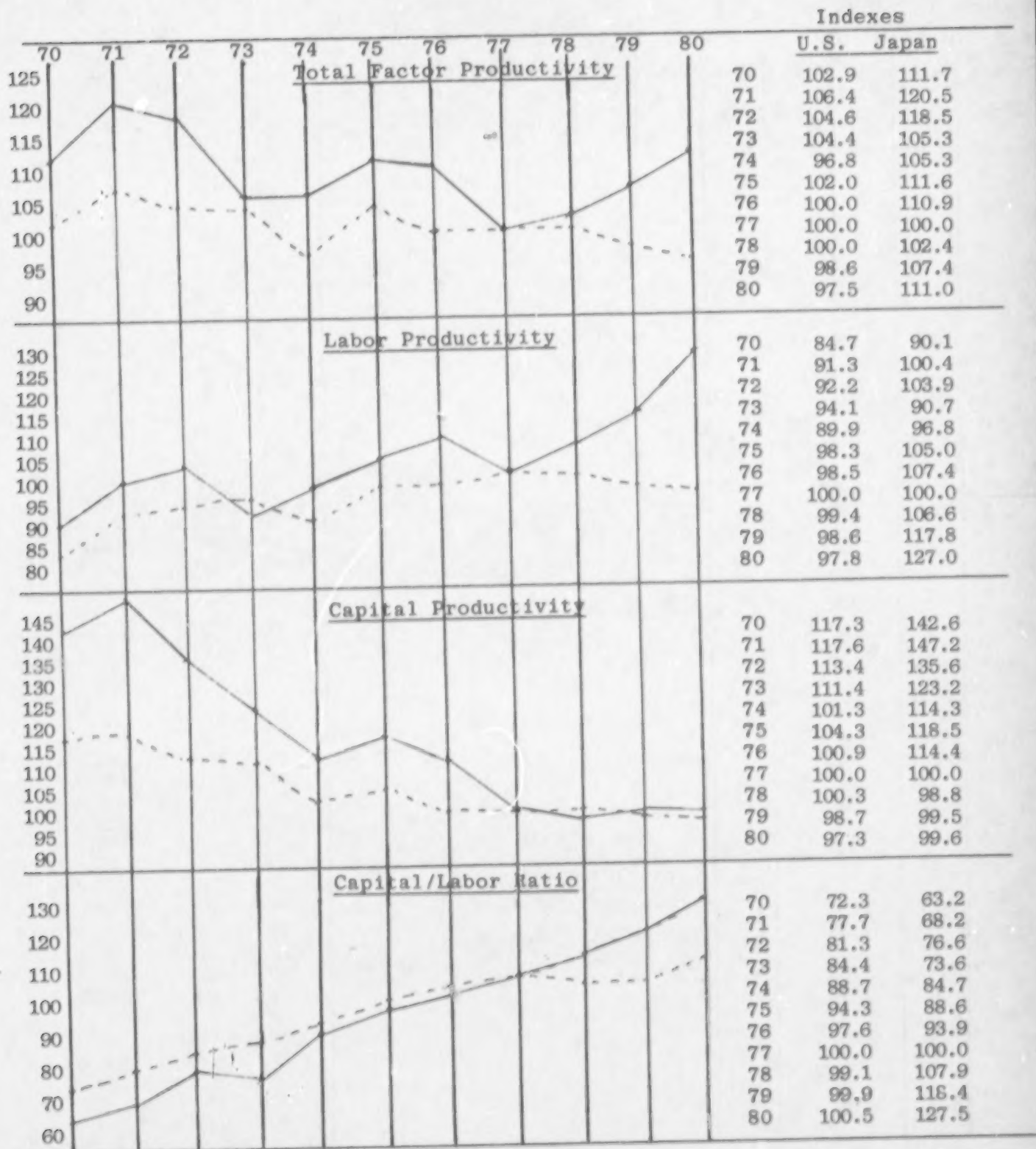
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Figure 9 Productivity Dynamics in the Seventies,
Transportation and Communications Sectors
U.S. and Japan



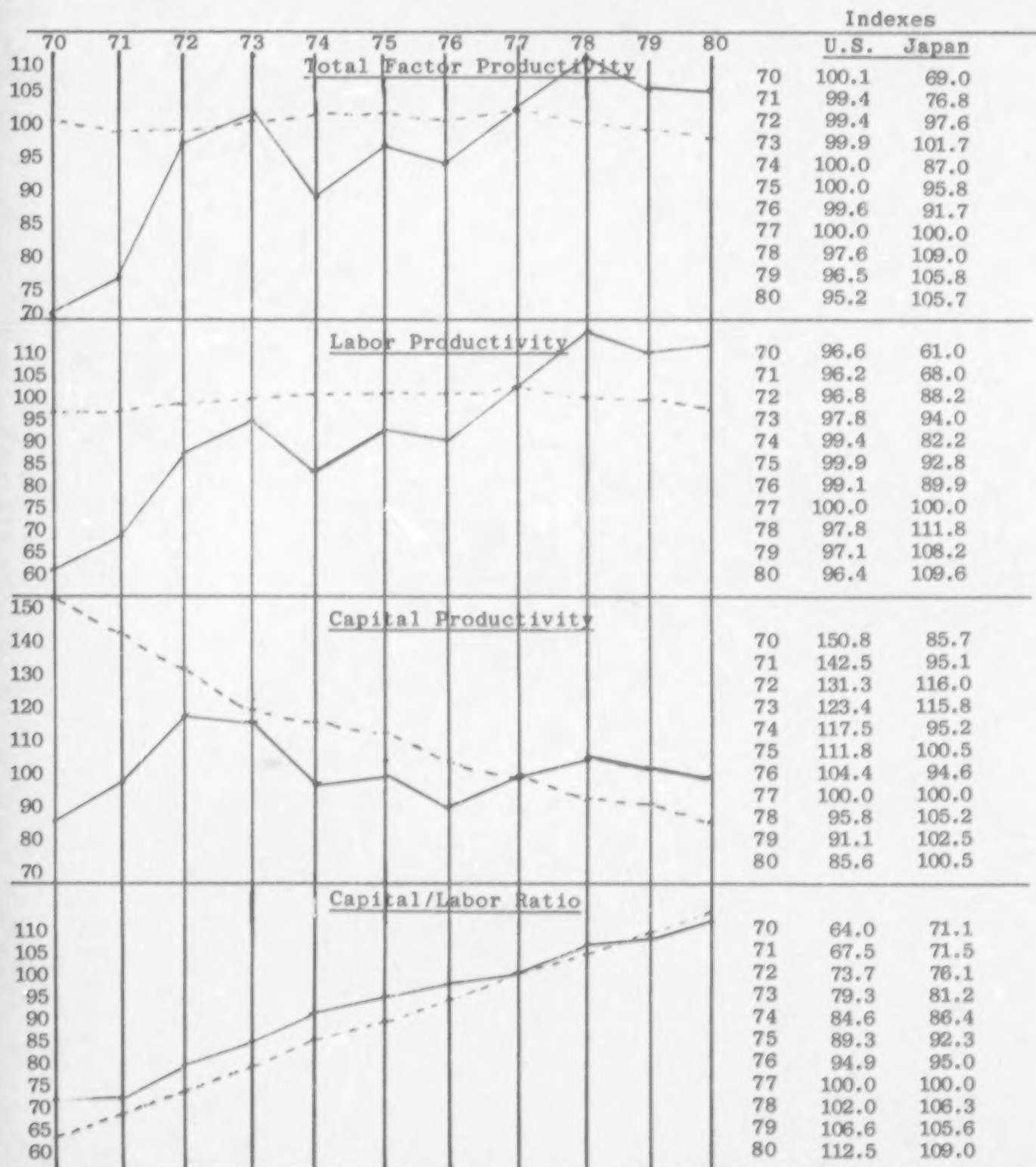
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Figure 10. Productivity Dynamics in the Seventies,
Public Utilities
U.S. and Japan



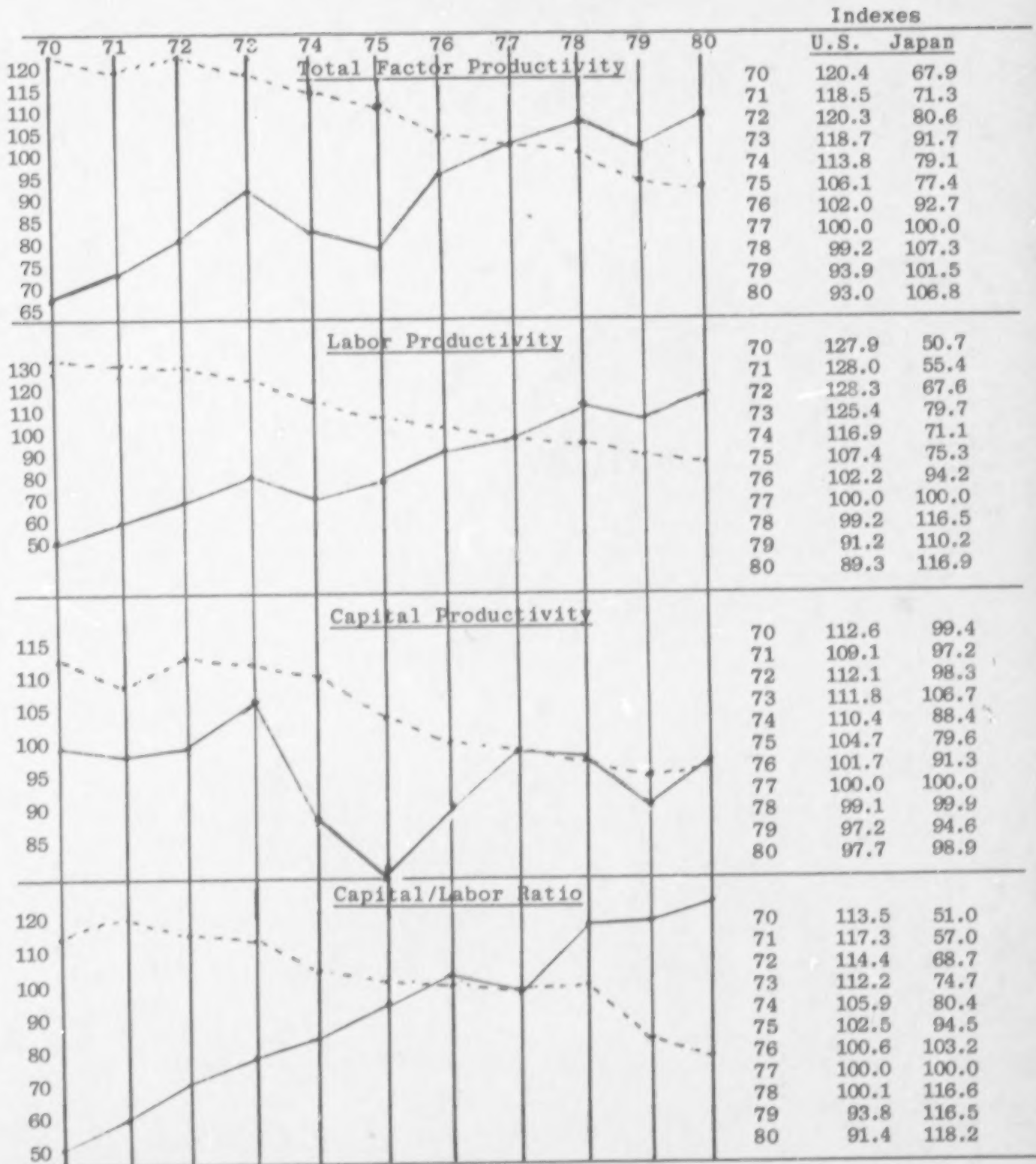
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Figure 11. Productivity Dynamics in the Seventies,
Finance and Insurance Industry
U.S. and Japan



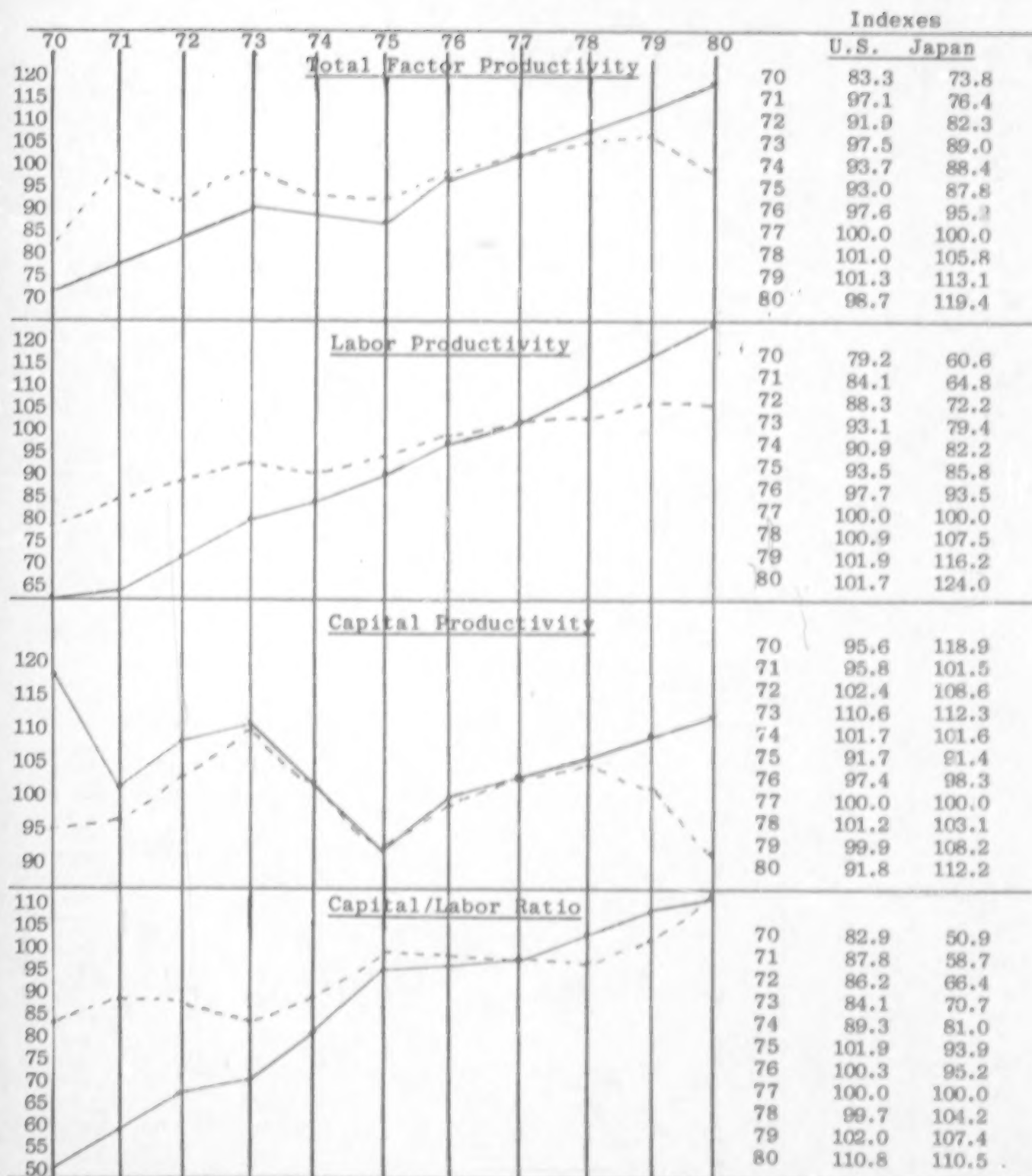
Code: U.S. = -----
Japan = —————

Figure 12 Productivity Dynamics in the Seventies,
Mining Industry
U.S. and Japan



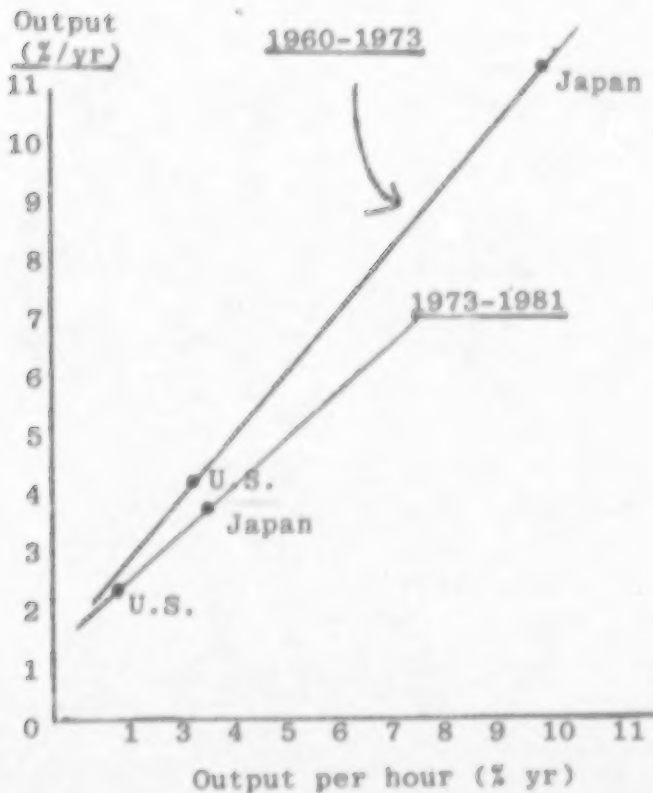
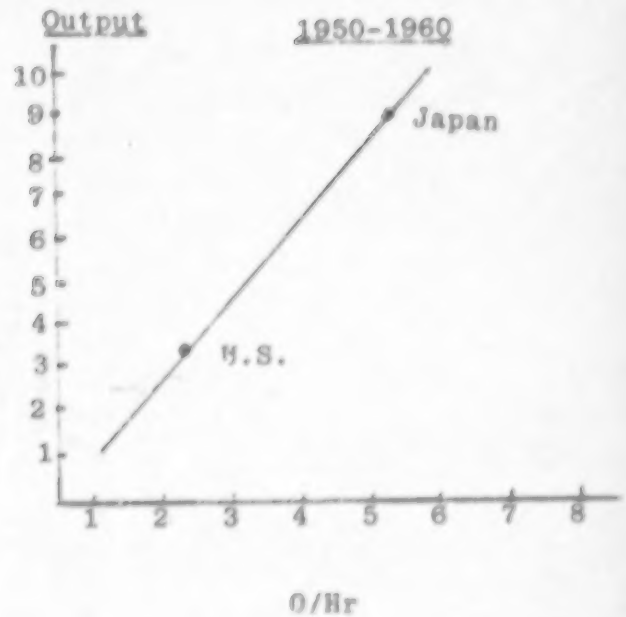
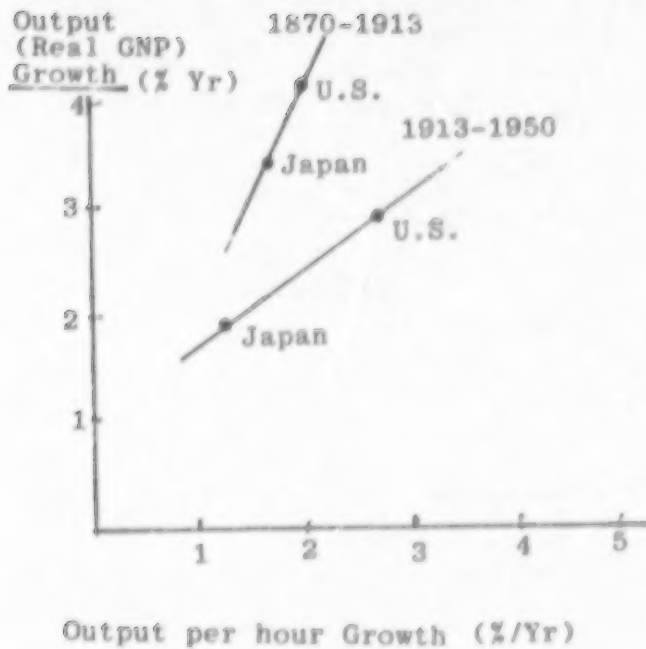
Code: U.S. = -----
Japan = —————

Figure 13. Productivity Dynamics in the Seventies,
Manufacturing Industry
U.S. and Japan



Code: U.S. = -----
Japan = —————

Figure 14.
Growth of Real Output Related to Growth in Output per Hour
(Average Annual Percent of Change, Selected periods.)

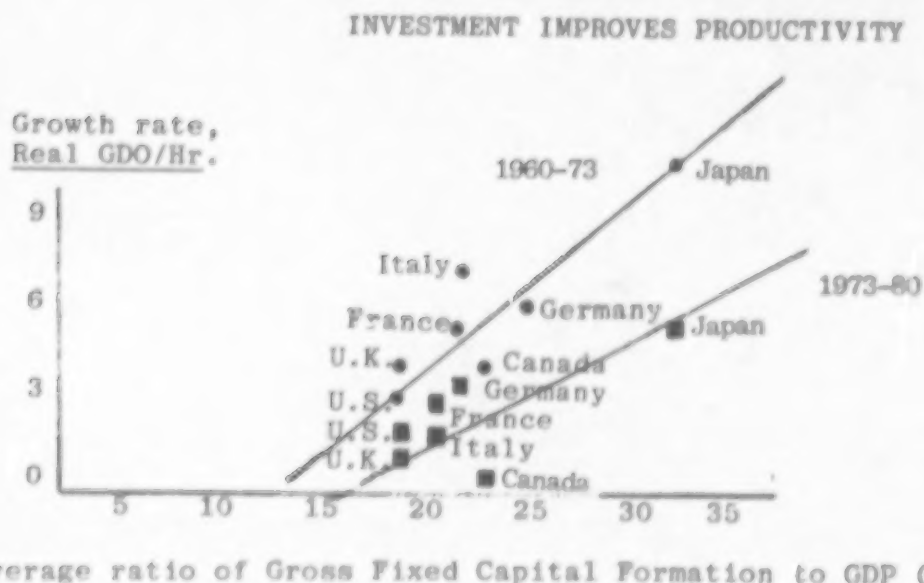


Data: Growth of Real national output and labor productivity:

	Output	Labor PTY
1870-1913:		
U.S.	4.2	2.0
Japan	3.3	1.8
1913-1950:		
U.S.	2.9	2.6
Japan	1.9	1.3
1950-1960:		
U.S.	3.2	2.4
Japan	8.9	5.7
1960-1973:		
U.S.	4.4	3.1
Japan	10.8	9.9
1973-1981:		
U.S.	2.3	0.9
Japan	3.8	3.6

Source: American Productivity Center
Based on data from: APC; Kendrick; A. Maddison; V. Catto; H. Stein; BLS; OECB.

Figure 15.
Average annual ratio of Investments to GDP
related to Trends in Real GDP per Hour.
Selected Nations, 1960-73; 1973-80.



Code: 1960-1973 = ●
1973-1980 = ■

Data table:

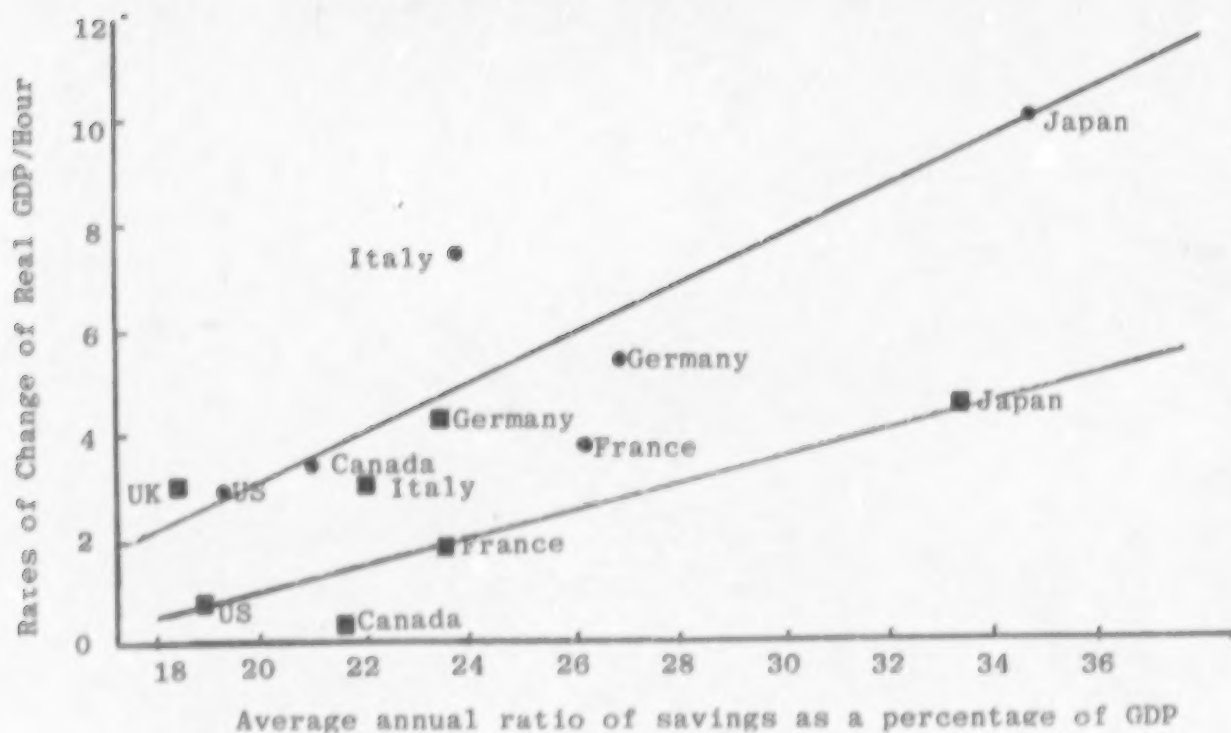
Country	Real GDP per hour		Average annual ratio of Gross Fixed Capital Formation as Percent of GDP	
	60-73	73-80	1960-73	1973-80
U.S.	2.6	1.2	18.1	18.48
Japan	9.8	3.8	32.7	32.59
Germany	5.4	3.8	25.0	22.0
France	5.6	3.4	21.1	22.6
U.K.	3.8	1.8	18.1	18.7
Italy	6.9	2.7	21.2	20.1
Canada	3.0	0.5	21.9	22.9

Source: American Productivity Center

Basic Data: Maddison (Real GDP per hour) ODEC (Annual Ratio
of investment to GDP)

Figure 16.

Rate of Change of Real GDP per hour versus average annual rate of Savings as a percent of Gross Domestic Product in Nine Countries, 1960-1973 and 1973-1980.



Code: 1960-1973 = ●
1973-1980 = ■

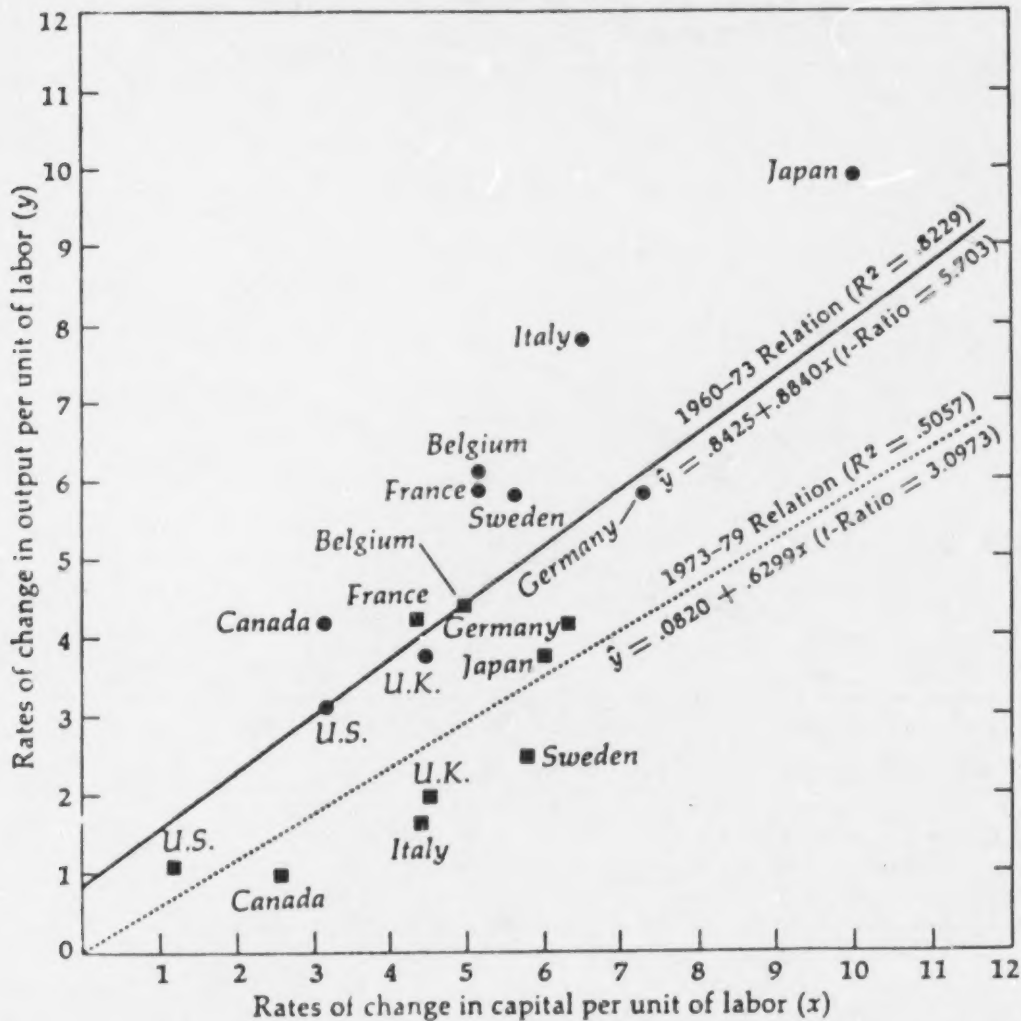
Basic Data: GCP per hour trends: Maddison, op.cit.
Savings as percent of GDP: OECD.

Country	Ratio of Savings to GDP %		GDP/Hour	
	69-73	73-80	69-73	73-80
U.S.	19.4	19.0	2.6	1.2
Japan	35.5	33.3	5.8	3.8
Germany	27.2	23.6	5.4	3.8
France	25.2	23.6	3.8	1.8
U.K.	19.1	18.5	6.9	2.7
Italy	23.9	22.1	6.9	2.7
Canada	21.6	21.8	3.0	0.5

Source: American Productivity Center

Figure 17.

Rates of Change in Output per Unit of Labor versus
Rates of Change in Capital per Unit of Labor in Private Business Economics,
Nine Countries, 1960-1973 and 1973-1979.

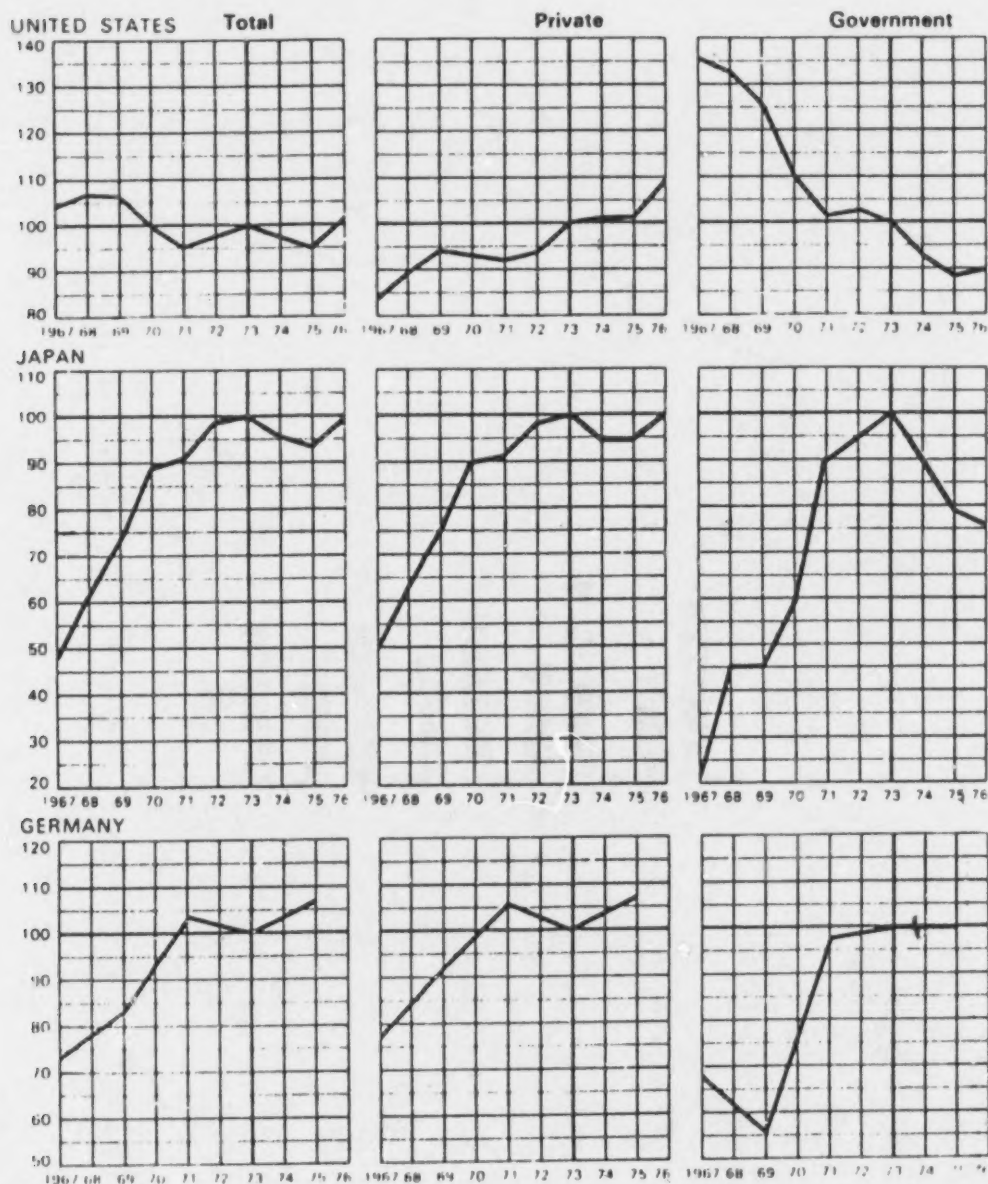


1960-73 = ●
1973-79 = ■

Source: Kendrick, John W., "International Comparisons of Recent Productivity Trends", in "Essays in Contemporary Economic Problems: Demand, Productivity and Population", American Enterprise Institute, Washington, D.C. 1981.

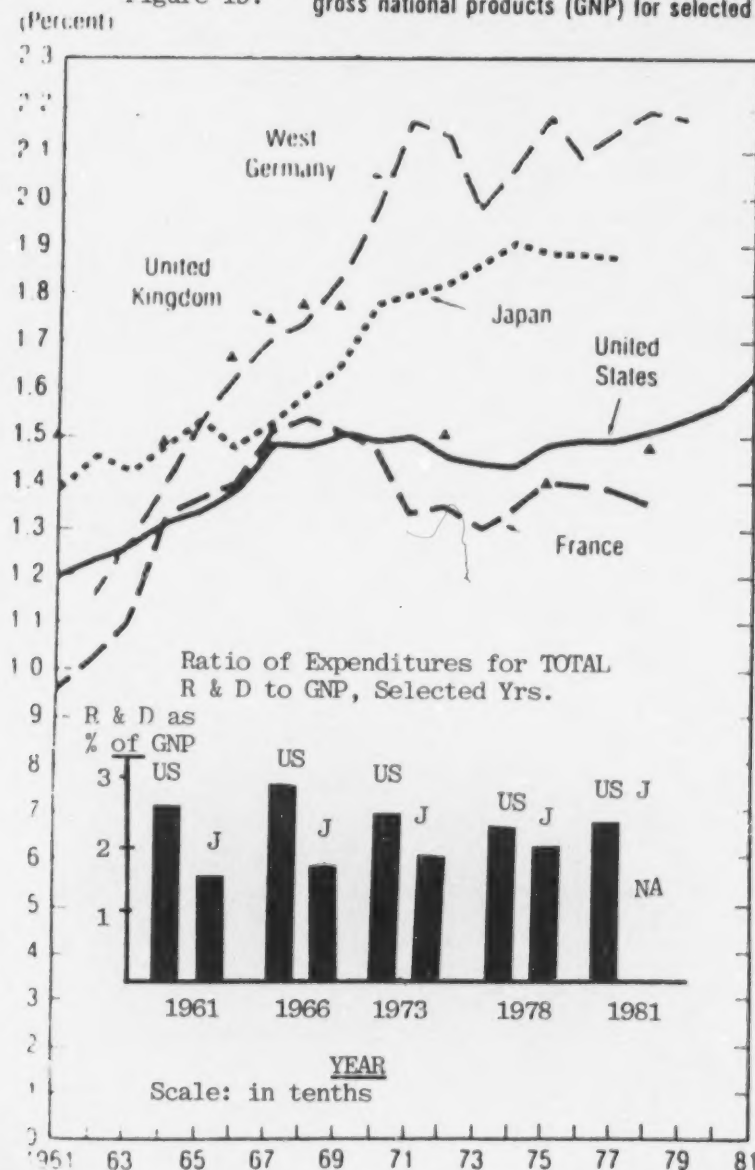
	U.S.		Canada		Japan		U.K.		France		W. Germ.		Italy		Sweden		Belgium	
	60-73	73-79	60-73	73-79	60-73	73-79	60-73	73-79	60-73	73-79	60-73	73-79	60-73	73-79	60-73	73-79	60-73	73-79
Output per Unit of labor	3.1	1.1	4.2	1.0	9.9	3.8	3.8	1.9	5.9	4.2	5.8	4.3	7.8	1.6	5.8	2.5	6.1	4.4
Capital/labor ratio	3.2	1.3	3.1	2.6	10.0	6.0	4.5	4.5	5.2	5.3	7.3	6.2	6.5	2.4	5.7	5.8	5.2	5.0

Figure 18. Trend in R & D Expenditures, Constant Prices, U.S., Japan and Germany. 1967-76.



Source: excerpted from Dunn, Robert H., Jr. "Economic Growth Among Industrialized Countries: Why the United States Lags", National Planning Association, Washington, D.C. 1980, page 46.

Figure 19. Estimated ratio of civilian R & D expenditures to gross national products (GNP) for selected countries



1/ National expenditures excluding Government funds for defense and space R & D - NSF, "Science Indicators - 1980", p. 9.

Source: APC

Basic Data: Estimated ratio of total R & D expenditures to gross national product (GNP) for U.S. and Japan: 1961-81.

Year	Japan	U.S.
Ratio of R & D expenditures to GNP		
1961	1.39	2.73
1966	1.48	2.88
1973	1.89	2.32
1978	1.93	2.23
1981 (est.)	NA	2.37

Estimated civilian R & D expenditures as a percent of GNP

Year	Japan	U.S.
1961	1.37	1.20
1962	1.46	1.23
1963	1.43	1.29
1964	1.47	1.31
1965	1.52	1.33
1966	1.59	1.39
1967	1.64	1.48
1968	1.59	1.46
1969	1.64	1.49
1970	1.77	1.50
1971	1.81	1.46
1972	1.81	1.44
1973	1.85	1.43
1974	1.91	1.49
1975	1.89	1.50
1976	1.88	1.50
1977	1.87	1.52
1978	NA	1.54
1979 (prelim)	NA	1.57
1980 (est.)	NA	1.63
1981	NA	1.66

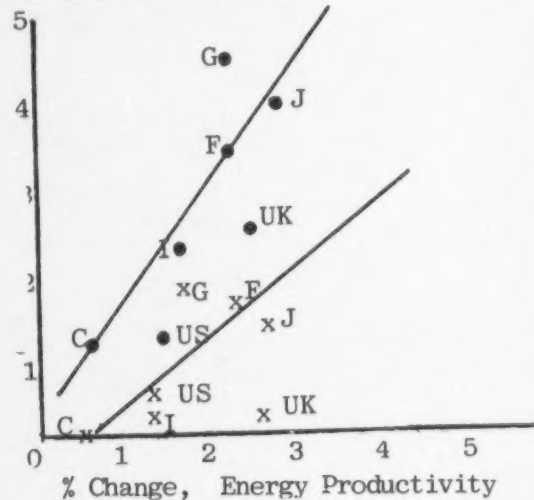
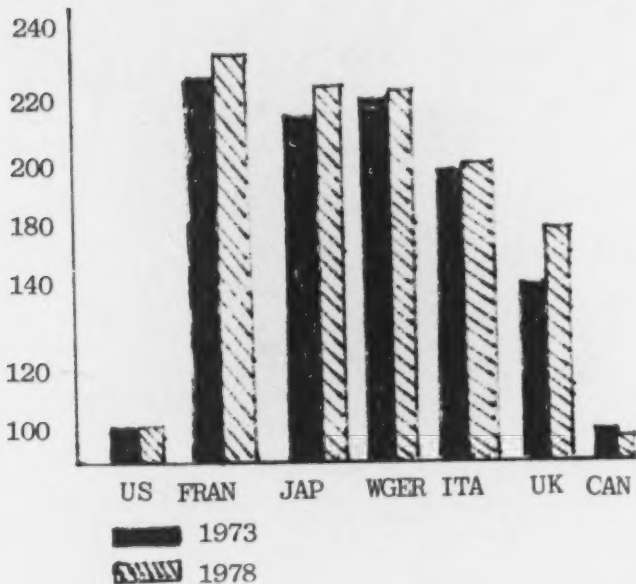
Figure 20.

Relative levels of energy productivity; and trends in energy, labor and total factor productivity, selected nations, 1973-78.

Productivity Growth Rates Related to Rate of Improvement in Energy Productivity. 1973-78.

Relative levels of Energy productivity
Selected Nations, 1973 and 1978 (US=100)

% Change, Productivity



● Output
X Total Factor Productivity

1. International Energy Productivity Level indexes. 1/

Country	1973	1978
(U.S. equals 100)		
U.S.	100	100
France	219	230
Japan	198	216
W. Germany	211	215
Italy	170	174
U.K.	139	149
Canada	81	79

Energy, Labor and Total Factor Productivity Rates

Energy Pty.	Real GDP per hour	Total Factor Pty. (Pvt. Bus)
(Average annual growth rate)		
1.3	1.5	0.6
2.3	3.5	1.8
2.9	3.9	1.3
1.6	4.3	1.9
1.7	2.1	0.2
2.5	2.5	0.3
0.8	1.3	0.0

1/ "Energy productivity" in this analysis is real (1979\$) gross national product divided by an aggregate figure on total energy useage (all forms) converted to barrels of oil equivalent

Basic data:

Energy productivity: APC - Benchmark 7.

Real GDP/hour: Maddison

Total factor productivity: Kendrick.

Source: American Productivity Center

APPENDICES

Appendix 1.

SUMMARY NOTE ON SOURCES OF DATA AND METHODOLOGY, U.S. - Japan Multiple Input Productivity Comparison.

Basically, the sources of data and methodology used to estimate total factor productivity are the same as detailed in Productivity in the United States, Trends and Cycles (The John Hopkins University Press, 1980), by Drs. John W. Kendrick and Elliot S. Grossman.

A. UNITED STATES

Real Output

Output is the annual series of gross product originating in constant 1972 dollars as estimated by the Bureau of Economic Analysis (B.E.A.) in its National Income and Product Accounts program. Each industry is used directly as published except for real estate, which excludes owner-occupied nonfarm housing and rental value of nonprofit real estate. In this study, the definition of services output differs from the usual APC series in order to ensure comparability with Japan data. Further, the farming sector includes farm and agricultural services; forestry; and fisheries, unlike the usual APC series which excludes agricultural services.

Output for the manufacturing and non-farm non-manufacturing segments are the sum of their individual industry outputs. The sum of these two segments plus farming yields output for the private domestic business economy.

Labor Hours

In general, labor hours are based on B.L.S. data. These B.L.S. figures represent total hours paid for, not hours actually worked. Employment for each industry includes employees on nonagricultural payrolls (production and nonproduction workers); self-employed persons (formerly termed proprietors); and unpaid family workers. The figures on all persons employed are then multiplied by their respective average hours worked per week and the sum total of these products is multiplied by 52 weeks to derive hours of all persons.¹

Capital Input

The APC productivity data uses the same sources of data and methodology to estimate real capital as the Kendrick-Grossman study. The only changes

1 This approach is consistent in theory with the "hours paid for" concept assuming vacation time, sick leave, holidays, etc., are in fact paid for, as provided in many union agreements.

are with respect to the most recent revisions in investment data, deflators, and inventory. For the most part, these revisions are minor and only affect the more current years.

In general, fixed capital is estimated using the perpetual inventory method. That is,

$$GK_t = GK_{t-1} (1-R) + GI_t$$

where, GK_t is current fixed capital,

GK_{t-1} is fixed capital from the previous period,

R is the retirement rate, and GI_t is the current level of investment.

Unlike the regularly published APC series, imputations for land and end-of-period inventory are not included.

Sector fixed capital is controlled to B.E.A. estimates except for non-farm, non-manufacturing. That is, farming and manufacturing end-of-year fixed capital is taken to be the B.E.A. estimates. Further, the residential tenant-occupied (i.e., rental) portion of real estate is taken directly from B.E.A. estimates. The remaining fixed capital estimates for the non-farm non-manufacturing industries are a continuation of the original estimates as published in Capital Stock Estimates for Input-Output Industries: Methods of Data, Bulletin 2034, U.S. Department of Labor, Bureau of Labor Statistics, 1979.

Input Weights

In order to derive total factor productivity, indexes of labor and capital inputs must be added together, and the ratio of the index of output to total factor input must be derived:

$$TFP = \frac{O}{W_L L + W_K K}$$

where,

O is index of real output

L is index of labor hours

K is index of gross fixed capital stock

W_L is labor share of factor costs

W_K is capital share of factor costs

and $W_L + W_K = 1.0$

The weights are derived from national income and labor compensation data by industry provided by the Bureau of Economic Analysis:

1. National income
2. + Capital consumption allowance

3. Adjusted national income
4. Labor compensation of all persons
5. Capital compensation

$$W_L = \frac{\text{Labor compensation}}{\text{Adj. National income}}$$

$$W_K = \frac{\text{Capital compensation}}{\text{Adj. National income}}$$

The year 1978 is chosen as the base year for weighting purposes. Since the series only covers a ten year period, this weight is fixed.

B. JAPAN

We greatly appreciate the cooperation and support of the Japan Productivity Center, Tokyo, which kindly provided all of the data on Japan.

Real Output

Real output by sector is measured in constant 1975 Yen (market prices). Individual industries are added where necessary in order to obtain a consistent set of industry data comparable to the U.S. The source is "Report on Revised National Accounts on the basis of 1975," Economic Planning Agency, November 1980, Table 17: Gross Domestic Product and Factor Income by kind of Economic Activity.

Labor Hours

Labor hours in Japan are measured on an hours worked rather than hours paid basis as is United States data. This discrepancy between U.S. and Japan data should not be very serious. First, the divergence between hours worked and hours paid should not have grown much over the past ten years, i.e., there should not be much of an impact on trends. Second, in the United States the difference between hours worked and hours paid is about five to seven percent, i.e., the downward bias in labor productivity levels for the United States is small.

The number of employed persons is obtained from "Report on Revised National Accounts on the basis of 1975," EPA, Table 20: Employed persons by kind of Economic Activity, (All persons), November 1980. Hours worked is from the "Annual Report of Monthly Labor Statistics," Labour Ministry, 1980. The average hours worked per month is multiplied by 12 and by total employment in order to derive total hours worked.

Capital Input

Gross fixed capital stock in 1975 market prices (constant 1975 Yen) are obtained from "Private Business Capital Stock," EPA, (occasional report), Table 1-2. Gross capital stock by Industry - All Business Enterprises, March, 1980. Figures for land and inventories are not included.

Input Weights

1978 weights were taken from published data on Domestic Factor Income and Employee Income, from "New-SNA", EPA, 1980. Capital compensation was assumed to be the residual of domestic factor income less employee income.

Appendix 2.

APC Japan/U.S. Binary Data Tables.

1. Levels of real output per hour for the economy, sectors and industries, 1970-80: United States.
2. Levels of real output per hour for the economy, sectors and industries, 1970-80: Japan.
3. Trends in Total Factor Productivity: United States.
4. Trends in Total Factor Productivity: Japan.
5. Trends in Labor Productivity: United States.
6. Trends in Labor Productivity: Japan.
7. Trends in Capital/Labor Ratio: United States.
8. Trends in Capital/Labor Ratio: Japan.
9. Trends in Real Output: United States.
10. Trends in Real Output: Japan.
11. Trends in Labor Input: United States.
12. Trends in Labor Input: Japan.
13. Trends in Capital Input: United States.
14. Trends in Capital Input: Japan.

Appendix II, Table 1.
Levels of Output per Hour, United States
(in constant 1975 \$ per hour)
1970-80

Industry/ Segment	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	\$ 8.27	\$ 8.57	\$ 8.83	\$ 9.06	\$ 8.28	\$ 8.99	\$ 9.21	\$ 9.36	\$ 9.36	\$ 9.33	\$ 9.27
Agriculture	6.17	6.34	6.17	6.24	6.32	6.67	6.60	6.80	6.61	6.94	7.21
Nonfarm Nonmanufacturing	8.64	8.87	9.08	9.19	8.10	9.04	9.19	9.30	9.27	9.16	9.07
Mining	27.58	27.61	27.67	27.05	25.22	23.16	22.05	21.57	21.40	19.67	19.26
Construction	9.45	9.93	9.74	9.36	8.35	8.51	9.03	8.75	8.34	7.79	7.43
Transportation & Comm.	9.29	9.67	10.14	10.48	10.83	11.33	11.84	12.14	12.49	12.72	13.13
Electricity, Gas & Water	21.98	23.69	23.92	24.40	23.32	25.50	25.54	25.94	25.79	25.56	25.38
Trade	6.88	7.11	7.45	7.70	7.55	7.66	7.83	7.95	8.05	8.08	7.92
Finance & Insurance	8.21	8.18	8.23	8.32	8.45	8.49	8.43	8.50	8.32	8.26	8.20
Business Services	6.79	6.84	6.98	7.10	5.04	6.80	6.80	6.85	6.84	6.80	6.70
Manufacturing	7.92	8.40	8.83	9.30	9.09	9.35	9.76	10.00	10.08	10.18	10.17
Food & Tobacco	9.51	10.09	10.77	12.04	11.43	11.89	12.10	12.14	12.13	12.55	13.35
Textiles	5.11	5.33	5.45	5.60	5.33	5.65	6.03	6.88	7.01	7.28	7.10
Pulp & Paper	8.28	9.04	9.84	10.75	11.02	10.25	10.91	11.16	11.30	11.58	11.16
Chemicals	10.26	11.28	12.37	13.20	12.67	13.32	14.35	14.62	14.72	15.32	14.91
Primary Metals	11.51	12.13	12.52	13.47	13.52	11.96	12.09	11.66	12.19	12.41	12.01
Fabricated Metals	8.53	8.66	8.97	9.27	8.60	8.80	9.47	9.80	9.71	10.02	10.05
Machinery exc. Elec.	8.54	8.78	9.25	9.34	9.18	9.20	9.86	10.06	10.01	10.11	10.04
Electrical Machinery	6.90	7.44	7.96	8.01	7.54	8.11	8.60	9.27	9.88	10.01	10.22
Transportation Equipment	8.47	9.85	10.28	10.91	10.62	11.07	12.08	12.60	12.38	11.60	10.90
Other Manufacturing ¹	6.56	6.80	7.11	7.47	7.45	7.83	7.89	7.94	8.01	8.12	8.23
Service Producing ²	8.16	8.37	8.62	8.80	7.75	8.77	8.89	9.06	9.08	9.04	8.98
Goods Producing ³	8.37	8.80	9.04	9.33	9.02	9.26	9.61	9.76	9.72	9.70	9.68

¹ Includes Apparel; Lumber; Furniture; Printing & Publishing; Petroleum; Stone; Clay, Stone & Glass; Leather; Instruments; and Miscellaneous Manufacturing.

² Includes Nonfarm Nonmanufacturing exclusive of Mining and Construction.

³ Includes Manufacturing, Agriculture, Mining and Construction.

Appendix II, Table 2.
Level of Output
per Hour Worked Japan
(in constant 1975 U.S. Dollars per hour¹)
1970-80

Industry Segment	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	\$ 3.59	\$ 3.82	\$ 4.29	\$ 4.64	\$ 4.73	\$ 4.89	\$ 5.01	\$ 5.18	\$ 5.39	\$ 5.69	\$ 6.01
Agriculture	1.37	1.42	1.76	2.05	2.11	2.18	2.10	2.10	2.13	2.29	2.38
Nonfarm Nonmanufacturing	4.15	4.34	4.77	5.00	5.04	5.18	5.13	5.21	5.33	5.49	5.68
Mining	5.07	5.54	6.75	7.96	7.10	7.52	9.41	9.99	11.64	11.00	11.67
Construction	3.85	3.89	4.12	4.25	4.06	4.44	4.10	4.14	4.27	4.29	4.13
Transportation & Comm.	3.86	3.98	4.07	4.29	4.74	4.76	4.84	4.86	4.79	4.90	5.66
Electricity, Gas & Water	14.01	15.61	16.16	14.09	15.05	16.32	16.69	15.55	16.58	18.31	19.74
Trade	2.88	3.10	3.60	3.90	3.98	3.99	4.06	4.08	4.25	4.48	4.53
Finance & Insurance	6.69	7.46	9.68	10.32	9.03	10.18	9.86	10.98	12.27	11.88	12.03
Business Services	3.39	3.38	3.58	3.60	3.60	3.53	3.41	3.40	3.32	3.44	3.60
Manufacturing	3.91	4.18	4.66	5.12	5.31	5.54	6.04	6.46	6.94	7.50	8.00
Food & Tobacco	3.81	4.26	4.35	5.61	6.03	6.39	6.08	6.78	5.80	6.63	7.07
Textiles	1.58	1.62	1.73	1.82	2.47	2.54	2.59	2.78	2.58	2.76	2.93
Pulp & Paper	5.11	5.54	6.78	7.13	6.83	7.55	8.47	8.16	9.03	9.90	9.20
Chemicals	6.54	8.44	10.21	10.48	10.63	10.56	11.53	14.68	19.00	18.82	17.77
Primary Metals	8.61	9.94	11.66	13.20	12.12	13.74	16.11	16.07	17.79	21.52	21.43
Fabricated Metals	3.32	3.52	4.02	4.85	4.16	3.73	3.88	4.32	4.95	5.14	4.75
Machinery Exc. Elec.	4.03	4.27	4.36	4.59	4.78	5.26	5.95	6.14	7.09	7.60	7.98
Electrical Machinery	2.78	3.18	4.14	5.03	5.68	5.41	6.87	7.80	9.11	10.96	13.32
Transportation Equipment	5.19	5.05	5.18	5.89	6.82	7.02	7.84	8.18	8.60	9.37	10.30
Other Manufacturing ²	3.83	3.87	4.23	4.26	4.16	4.42	4.66	4.80	5.09	4.98	5.13
Services Producing	4.20	4.43	4.91	5.16	5.26	5.35	5.35	5.43	5.55	5.75	6.03
Goods Producing	3.14	3.36	3.80	4.22	4.29	4.49	4.70	4.95	5.25	5.64	5.99

¹ Japan real output in 1975 yen was converted to 1975 U.S. dollars using the 1970 Purchasing Power Parity as published by I. Kravis, extrapolated to 1975; PPP in 1975 was 272.5 yen per U.S. dollar; see R. Summers, I. Kravis, and A. Heston, "International Comparison of Real Product and its Composition: 1950-77," in The Review of Income and Wealth, Series 26, Number 1, March 1980.

² Includes Apparel; Lumber; Furniture; Printing & Publishing; Petroleum; Stone; Clay, Stone & Glass; Leather; Instruments; and Miscellaneous Manufacturing.

Appendix II, Table 3. Trends in
Total Factor Productivity
United States
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	92.2	94.4	97.3	99.7	92.5	95.7	98.2	100.0	100.5	100.0	97.9
Agriculture	112.4	114.8	110.9	107.6	106.0	106.7	100.4	100.0	97.2	100.2	100.0
Nonfarm Nonmanufacturing	95.5	97.2	99.2	100.1	91.8	96.9	98.5	100.0	100.4	99.4	97.8
Mining	120.4	118.5	120.3	118.7	113.8	106.1	102.0	100.0	99.2	93.9	93.0
Construction	109.2	114.6	112.3	108.5	96.0	95.1	101.7	100.0	97.1	91.5	86.8
Transportation & Commun.	81.3	83.3	87.5	90.1	92.0	93.7	97.4	100.0	103.4	105.2	107.0
Electricity, Gas & Water	102.9	106.4	104.6	104.4	96.8	102.0	100.0	100.0	100.0	98.6	97.5
Trade	89.8	92.4	96.3	98.8	96.0	96.6	98.7	100.0	101.0	100.7	97.6
Finance & Insurance	100.1	99.4	99.4	99.9	100.9	100.9	99.6	100.0	97.6	96.5	95.2
Real Estate	87.9	90.9	91.1	89.5	90.4	88.3	91.7	100.0	99.7	96.9	99.1
Business Services	99.9	99.7	101.7	103.1	79.2	98.9	99.0	100.0	100.3	100.0	98.8
Manufacturing	83.3	87.1	91.9	97.5	93.7	93.0	97.6	100.0	101.0	101.3	98.7
Food & Tobacco	82.8	87.0	92.2	102.3	96.4	98.9	100.6	100.0	99.1	102.3	107.7
Textiles	77.5	80.4	82.5	84.6	78.5	80.9	87.9	100.0	101.4	104.6	100.9
Pulp & Paper	78.7	85.0	92.8	101.5	102.5	91.4	98.0	100.0	100.2	101.1	95.0
Chemicals	76.6	82.6	90.2	96.5	91.7	92.7	99.4	100.0	100.1	102.8	98.1
Primary Metals	102.3	105.7	109.8	120.0	120.0	102.0	103.3	100.0	105.1	107.1	100.2
Fabricated Metals	91.2	91.2	95.1	98.7	90.4	89.5	96.5	100.0	99.0	101.6	99.4
Machinery Exc. Elec.	89.0	88.9	94.4	96.9	94.8	92.2	98.0	100.0	100.0	100.4	98.1
Electrical Machinery	78.5	82.9	89.1	90.2	83.6	86.4	92.1	100.0	106.8	108.1	108.3
Transportation Equipment	70.1	80.7	84.0	90.4	85.4	86.8	95.7	100.0	98.2	90.8	81.6
Other Manufacturing 1/	87.5	89.7	94.2	98.9	96.5	97.1	99.0	100.0	100.9	101.4	100.0

1 The "Other manufacturing" combination includes data for the following industry groups, for which comparable separate data was not provided by the Japan Productivity Center: Apparel; lumber; furniture; printing and publishing; petroleum; stone, clay and glass products; leather; instruments; and miscellaneous manufactures.

Source: American Productivity Center

Appendix II, Table 4, Trends in
Total Factor Productivity
Japan
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	86.3	88.7	95.7	100.4	97.9	97.6	98.7	100.0	102.3	105.5	108.5
Agriculture	137.6	125.4	135.0	137.9	129.3	121.8	107.8	100.0	94.6	90.4	82.6
Nonfarm Nonmanufacturing	96.1	98.0	104.2	106.1	102.4	102.7	100.4	100.0	100.6	101.2	102.2
Mining	67.9	71.3	80.6	91.7	79.1	77.4	92.7	100.0	107.3	101.5	106.8
Construction	109.5	108.0	111.0	111.6	102.9	110.0	100.7	100.0	102.6	100.9	95.2
Transportation & Commun.	83.6	85.4	86.3	90.5	98.6	98.5	100.3	100.0	98.3	100.0	114.6
Electricity, Gas & Water	111.7	120.5	118.5	105.3	105.3	111.6	110.9	100.0	102.4	107.4	111.0
Trade	83.2	87.8	99.2	104.4	102.6	100.7	100.7	100.0	102.1	105.3	104.4
Finance & Insurance	69.0	76.8	97.6	101.7	87.0	95.8	91.7	100.0	109.0	105.8	105.7
Real Estate	129.0	117.7	109.0	107.5	104.9	99.1	100.0	100.0	101.2	104.3	106.3
Business Services	124.7	120.6	123.9	119.8	114.3	108.6	103.0	100.0	95.1	95.6	95.6
Manufacturing	73.8	76.4	82.3	89.0	88.4	87.8	95.2	100.0	105.8	113.1	119.4
Food & Tobacco	74.3	77.9	74.7	93.0	95.1	96.3	92.0	100.0	83.2	91.9	94.5
Textiles	67.3	67.1	68.9	71.0	92.3	91.2	92.9	100.0	93.1	99.9	103.4
Pulp & Paper	81.9	86.0	99.5	102.1	92.4	94.8	107.0	100.0	107.0	114.8	103.2
Chemicals	59.7	72.2	83.7	83.1	81.3	76.2	83.2	100.0	122.9	120.8	114.9
Primary Metals	79.1	85.8	94.1	103.2	90.4	93.6	104.6	100.0	105.2	125.4	129.4
Fabricated Metals	84.2	88.0	99.4	118.8	100.1	87.7	90.5	100.0	113.6	117.2	107.7
Machinery Exc. Elec.	72.7	75.7	76.0	79.5	81.5	86.3	97.2	100.0	113.8	121.7	128.0
Electrical Machinery	42.8	47.2	60.6	72.6	77.0	70.3	90.4	100.0	115.2	135.6	161.2
Transportation Equipment	75.4	71.5	71.1	79.0	88.0	86.8	95.8	100.0	102.9	110.6	120.9
Other Manufacturing	91.9	90.8	97.4	96.6	91.3	93.7	98.6	100.0	105.0	101.6	102.5

Source: American Productivity Center

Appendix II, Table 5. Trends in
Labor Productivity
United States
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	87.8	91.1	93.9	96.4	88.3	95.9	98.3	100.0	100.0	99.8	99.1
Agriculture	90.7	93.2	90.8	91.8	93.0	98.1	97.2	100.0	97.3	102.1	105.0
Nonfarm Nonmanufacturing	92.0	94.5	96.8	98.1	87.5	97.1	98.7	100.0	99.7	98.7	97.8
Mining	127.9	128.0	128.3	125.4	116.9	107.4	102.2	100.0	99.2	91.2	89.3
Construction	108.0	113.5	111.3	106.9	95.4	97.2	103.2	100.0	95.3	89.0	84.9
Transportation & Commun.	76.5	79.7	83.5	86.3	89.2	93.4	97.6	100.0	102.9	104.8	108.2
Electricity, Gas & Water	84.7	91.3	92.2	94.1	89.9	98.3	98.5	100.0	99.4	98.6	97.8
Trade	86.5	89.4	93.7	96.8	95.0	96.3	98.5	100.0	101.2	101.6	99.6
Finance & Insurance	96.6	96.2	96.8	97.8	99.4	99.9	99.1	100.0	97.8	97.1	96.4
Real Estate	94.7	95.1	95.0	92.5	93.7	93.5	95.9	100.0	92.1	84.9	85.9
Business Services	99.1	99.8	102.0	103.6	73.6	99.2	99.2	100.0	99.8	99.2	97.8
Manufacturing	79.2	84.1	88.3	93.1	90.9	93.5	97.7	100.0	100.9	101.9	101.7
Food & Tobacco	78.3	83.1	88.7	99.2	94.2	97.9	99.6	100.0	99.9	103.4	110.0
Textiles	74.3	77.5	79.2	81.4	77.4	82.1	87.7	100.0	101.9	105.8	103.2
Pulp & Paper	74.2	81.0	88.2	96.3	98.8	91.8	97.8	100.0	101.2	103.8	100.0
Chemicals	70.2	77.2	84.6	90.3	86.7	91.1	98.2	100.0	100.7	104.8	102.0
Primary Metals	98.7	104.0	107.4	115.5	115.9	102.5	103.7	100.0	104.6	106.4	102.9
Fabricated Metals	87.0	88.3	91.5	94.6	87.7	89.8	96.6	100.0	99.0	102.2	102.5
Machinery Exc. Elec.	84.9	87.3	91.9	92.9	91.2	91.5	98.0	100.0	99.5	100.5	99.8
Electrical Machinery	74.5	80.3	85.9	86.4	81.3	87.5	92.8	100.0	106.6	108.0	110.2
Transportation Equipment	67.2	78.2	81.5	87.0	84.3	87.9	95.8	100.0	98.2	92.0	86.5
Other Manufacturing	82.6	85.6	89.5	94.0	93.7	98.5	99.3	100.0	100.8	102.3	103.6

Source: American Productivity Center

Appendix II, Table G. Trends in
Labor Productivity
Japan
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	69.3	73.8	82.8	89.5	91.3	94.4	96.7	100.0	104.1	109.9	116.0
Agriculture	65.3	67.9	84.0	97.8	100.8	104.0	100.3	100.0	101.6	109.1	113.8
Nonfarm Nonmanufacturing	79.7	83.3	91.7	96.0	96.8	99.6	98.5	100.0	102.4	105.4	109.2
Mining	50.7	55.4	67.6	79.7	71.1	75.3	94.2	100.0	116.5	110.2	116.9
Construction	93.0	93.9	99.5	102.7	98.2	107.4	99.1	100.0	103.2	103.7	99.7
Transportation & Commun.	79.6	82.1	83.9	88.4	97.6	98.1	99.6	100.0	98.7	100.9	116.7
Electricity, Gas & Water	90.1	100.4	103.9	90.7	96.0	105.0	107.4	100.0	106.6	117.8	127.0
Trade	70.4	75.9	88.2	95.5	97.5	97.8	99.4	100.0	104.0	109.6	111.0
Finance & Insurance	61.0	68.0	88.2	94.0	82.2	92.8	89.9	100.0	111.8	108.2	109.6
Real Estate	96.0	91.7	98.7	96.1	96.6	101.0	105.5	100.0	98.8	104.3	107.2
Business Services	99.7	99.3	105.4	105.9	106.0	103.9	100.2	100.0	97.6	101.1	105.9
Manufacturing	60.6	64.8	72.2	79.4	82.2	85.8	93.5	100.0	107.5	116.2	124.0
Food & Tobacco	56.1	62.9	64.1	82.7	88.9	94.2	89.7	100.0	85.5	97.7	104.3
Textiles	56.6	58.1	62.0	65.2	88.8	91.2	92.9	100.0	92.7	99.3	105.3
Pulp & Paper	62.7	67.9	83.1	87.4	83.7	92.5	103.9	100.0	110.7	121.4	112.8
Chemicals	44.6	57.4	69.5	71.3	72.4	71.9	78.5	100.0	129.4	128.1	121.0
Primary Metals	53.6	61.9	72.5	82.1	75.4	85.5	100.2	100.0	110.7	133.9	133.3
Fabricated Metals	76.7	81.3	92.9	112.2	96.2	86.2	89.7	100.0	114.5	119.0	109.8
Machinery Exc. Elec.	65.5	69.5	71.1	74.7	77.8	85.7	96.8	100.0	115.3	123.8	129.9
Electrical Machinery	35.6	40.7	53.1	64.4	72.8	69.3	88.0	100.0	116.8	140.5	170.7
Transportation Equipment	63.5	61.8	63.3	71.9	83.4	85.8	95.9	100.0	105.1	114.5	125.9
Other Manufacturing (*)	79.9	80.6	88.2	88.8	86.7	92.1	97.1	100.0	106.1	103.8	106.9

Source: American Productivity Center

*Includes Apparel, Lumber, Furniture, Printing & Publishing,
Petroleum, Stone, Clay & Glass, Leather, Instruments,
& Miscellaneous Manufacturing

Appendix II, Table 7. Trends in
Capital - Labor Ratio
United States
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	87.2	90.4	90.7	91.1	87.9	100.4	100.3	100.0	98.8	99.4	103.1
Agriculture	76.1	76.7	77.5	81.8	84.8	90.0	96.0	100.0	100.0	102.4	107.5
Nonfarm Nonmanufacturing	90.5	92.9	93.8	94.9	88.1	100.5	100.6	100.0	98.3	98.2	100.0
Mining	113.5	117.3	114.4	112.2	105.9	102.5	100.6	100.0	100.1	93.8	91.4
Construction	95.6	96.0	96.7	94.3	97.1	108.8	105.7	100.0	92.4	89.4	91.3
Transportation & Commun.	82.3	86.9	86.2	87.2	90.9	99.0	100.4	100.0	98.6	98.8	103.3
Electricity, Gas & Water	72.3	77.7	81.3	84.4	88.7	94.3	97.6	100.0	99.1	99.9	100.5
Trade	84.8	86.9	89.0	91.8	95.9	98.7	99.3	100.0	101.1	103.9	108.6
Finance & Insurance	64.0	67.5	73.7	79.3	84.6	89.3	94.9	100.0	102.0	106.6	112.5
Real Estate	108.2	105.0	104.6	103.5	103.9	106.3	105.0	100.0	91.9	86.8	85.8
Business Services	97.0	100.4	101.1	101.9	73.5	101.4	100.7	100.0	98.2	97.0	95.9
Manufacturing	82.9	87.8	86.2	84.1	89.3	101.9	100.3	100.0	99.7	102.0	110.8
Food & Tobacco	82.8	85.8	87.8	90.2	92.7	96.8	97.1	100.0	102.6	103.6	106.9
Textiles	84.4	86.5	84.7	86.1	95.1	105.9	99.1	100.0	102.0	104.3	108.4
Pulp & Paper	81.2	84.6	83.7	83.3	87.9	101.7	99.2	100.0	103.4	108.9	117.3
Chemicals	78.6	83.1	84.1	83.3	86.1	95.6	97.0	100.0	101.6	105.0	110.2
Primary Metals	85.0	93.0	90.6	83.8	85.4	102.3	101.5	100.0	97.7	97.3	111.8
Fabricated Metals	78.1	84.5	81.8	79.7	86.1	101.7	100.4	100.0	99.8	102.8	114.8
Machinery Exc. Elec.	81.5	92.6	89.2	83.0	84.4	97.1	100.0	100.0	98.3	100.4	107.5
Electrical Machinery	79.1	87.2	85.2	82.7	89.0	105.2	102.8	100.0	99.0	99.7	107.4
Transportation Equipment	82.6	86.8	87.5	84.0	94.4	105.3	100.6	100.0	100.1	105.6	125.0
Other Manufacturing	83.0	86.0	84.8	84.8	91.2	104.5	101.2	100.0	99.7	102.6	111.0

Source: American Productivity Center

Appendix II, Table 8. Trends in
Capital - Labor Ratio
Japan
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	52.7	59.7	67.7	74.0	83.8	92.0	95.2	100.0	104.4	110.1	116.5
Agriculture	36.3	44.4	54.2	64.7	73.3	82.3	91.6	100.0	109.0	125.1	145.7
Nonfarm Nonmanufacturing	58.0	63.3	70.5	76.7	86.7	92.6	95.5	100.0	104.4	110.2	116.8
Mining	51.0	57.0	68.7	74.7	80.4	94.5	103.2	100.0	116.6	116.5	118.2
Construction	48.7	55.7	64.5	72.9	84.4	91.7	94.6	100.0	101.9	109.6	116.0
Transportation & Commun.	63.9	70.1	79.2	82.5	92.2	96.5	95.1	100.0	103.1	107.0	113.5
Electricity, Gas & Water	63.2	68.2	76.6	73.6	84.7	88.6	93.9	100.0	107.9	118.4	127.5
Trade	52.1	57.7	65.2	73.1	84.4	91.1	95.9	100.0	106.0	113.0	119.6
Finance & Insurance	71.1	71.5	76.1	81.2	86.4	92.3	95.0	100.0	106.3	105.6	109.0
Real Estate	72.9	76.6	90.1	88.9	91.6	102.0	105.8	100.0	97.5	100.0	100.9
Business Services	48.6	54.8	61.8	70.3	81.3	89.1	93.2	100.0	106.8	114.8	127.5
Manufacturing	50.9	58.7	66.4	70.7	81.0	93.9	95.2	100.0	104.2	107.4	110.5
Food & Tobacco	49.3	60.0	70.7	77.1	86.6	95.4	94.8	100.0	105.7	113.1	121.3
Textiles	53.6	60.5	70.7	76.1	88.9	100.3	100.2	100.0	98.6	98.2	105.4
Pulp & Paper	47.3	52.8	63.0	67.7	78.9	94.6	93.6	100.0	107.9	113.0	120.8
Chemicals	52.6	61.8	68.4	73.6	79.6	89.4	89.5	100.0	109.8	111.3	109.9
Primary Metals	44.4	51.9	60.5	64.7	71.4	85.0	92.8	100.0	109.0	111.7	105.2
Fabricated Metals	40.0	48.7	56.2	62.4	73.9	88.5	94.0	100.0	105.0	110.6	112.7
Machinery Exc. Elec.	49.4	58.4	67.0	69.3	77.3	96.5	98.0	100.0	106.9	108.8	107.4
Electrical Machinery	57.2	64.9	68.6	71.4	86.0	96.7	93.4	100.0	103.5	109.1	114.9
Transportation Equipment	55.9	62.2	69.5	75.1	85.4	96.8	100.3	100.0	106.0	109.8	111.5
Other Manufacturing	53.0	59.5	65.9	70.8	82.0	94.0	94.6	100.0	103.6	107.9	115.6

Source: American Productivity Center

Appendix II, Table 9. Trends in
Real Output
United States
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	78.8	81.5	86.9	92.7	91.3	89.3	94.5	100.0	105.1	108.4	107.2
Agriculture	93.3	97.5	96.2	95.8	97.3	100.6	97.2	100.0	101.1	107.4	109.0
Nonfarm Nonmanufacturing	78.9	82.0	86.7	91.0	90.6	90.6	94.8	100.0	105.2	108.3	108.9
Mining	95.7	93.2	96.1	97.0	97.3	95.4	96.6	100.0	103.9	106.3	111.6
Construction	96.5	104.7	107.3	108.7	96.3	87.3	95.4	100.0	106.3	105.2	98.2
Transportation & Commun.	74.1	75.3	81.3	86.6	89.2	88.8	94.1	100.0	108.2	114.4	116.7
Electricity, Gas & Water	80.7	86.4	89.1	93.5	90.0	96.1	96.5	100.0	104.9	107.8	110.2
Trade	76.4	80.3	86.4	91.5	89.7	90.8	95.4	100.0	104.9	107.5	105.3
Finance & Insurance	79.8	81.4	84.3	88.6	92.5	94.5	95.6	100.0	104.6	108.5	111.8
Real Estate	74.9	80.0	82.9	84.5	86.6	85.4	89.8	100.0	102.2	101.5	105.2
Business Services	78.0	79.0	84.0	89.2	91.0	91.4	95.2	100.0	105.4	109.9	113.0
Manufacturing	77.1	78.8	86.3	90.0	92.0	85.5	93.7	100.0	105.4	108.6	103.6
Food & Tobacco	83.8	86.9	91.7	101.0	95.5	96.4	100.1	100.0	100.1	104.7	109.9
Textiles	78.7	81.9	87.9	91.4	80.3	76.5	87.9	100.0	101.2	102.9	96.5
Pulp & Paper	74.2	78.6	87.8	98.2	99.3	82.9	94.6	100.0	102.2	105.2	99.2
Chemicals	68.8	73.0	79.9	87.6	85.4	85.0	95.1	100.0	103.3	109.0	105.5
Primary Metals	103.1	100.4	107.1	125.9	127.4	96.0	100.0	100.0	109.1	113.3	97.1
Fabricated Metals	85.2	81.7	89.9	100.0	90.4	81.3	92.0	100.0	104.4	110.3	102.9
Machinery Exc. Elec.	77.3	72.0	81.5	92.2	94.2	85.9	92.8	100.0	107.9	115.5	114.4
Electrical Machinery	73.2	74.0	83.1	90.7	84.0	77.8	86.7	100.0	113.6	121.4	122.3
Transportation Equipment	63.1	70.6	76.7	88.8	80.3	76.7	90.2	100.0	104.1	98.7	83.0
Other Manufacturing ^{1/}	78.0	80.3	88.6	96.7	93.5	88.7	95.0	100.0	105.2	107.8	103.8

^{1/} Output in real (constant 1975\$) value added for economy, sector and industries.

Source: American Productivity Center

Appendix II, Table 10. Trends in
Real Output
Japan
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	70.0	74.4	83.0	90.9	89.1	90.3	95.4	100.0	105.7	112.9	120.0
Agriculture	95.1	90.4	103.1	110.6	108.7	107.6	102.1	100.0	100.9	101.6	97.5
Nonfarm Nonmanufacturing	70.7	76.1	85.0	91.4	89.5	93.6	96.1	100.0	105.1	110.8	116.5
Mining	81.7	85.6	89.0	95.7	81.3	77.3	90.9	100.0	101.7	97.6	104.4
Construction	78.5	84.1	93.1	101.7	93.3	102.6	98.4	100.0	109.3	111.4	109.3
Transportation & Commun.	74.4	78.1	79.7	88.1	94.1	94.4	100.2	100.0	99.2	104.7	120.7
Electricity, Gas & Water	80.6	90.4	92.4	92.0	92.6	102.5	106.3	100.0	107.2	117.5	125.0
Trade	66.3	71.6	82.6	90.0	89.0	91.4	96.0	100.0	104.6	111.0	114.2
Finance & Insurance	52.8	62.9	81.9	84.9	73.6	86.7	87.9	100.0	111.5	111.4	115.4
Real Estate	62.0	67.3	72.4	82.0	86.4	88.4	94.0	100.0	104.9	113.4	123.1
Business Services	83.4	86.3	95.6	97.9	95.9	96.3	97.0	100.0	101.9	110.7	117.6
Manufacturing	65.3	69.4	76.7	87.4	85.7	82.2	93.2	100.0	107.3	118.0	129.1
Food & Tobacco	62.4	65.2	64.6	84.6	87.2	88.8	89.8	100.0	85.1	97.4	102.3
Textiles	75.5	76.1	75.6	79.4	96.2	89.5	93.8	100.0	94.5	101.8	103.5
Pulp & Paper	72.0	78.7	91.1	98.1	87.3	88.0	105.1	100.0	107.6	118.1	108.3
Chemicals	50.2	63.0	76.2	77.9	78.2	75.0	84.7	100.0	122.2	123.4	120.8
Primary Metals	63.8	72.4	83.2	95.0	84.8	86.6	99.7	100.0	103.9	126.1	135.0
Fabricated Metals	88.8	91.9	104.0	130.5	106.2	85.0	89.1	100.0	115.3	123.3	121.9
Machinery Exc. Elec.	75.0	78.0	77.7	85.6	87.3	82.6	96.0	100.0	111.1	122.8	138.2
Electrical Machinery	37.9	41.8	55.5	71.7	73.0	64.2	87.9	100.0	119.4	148.6	192.7
Transportation Equipment	60.2	60.0	62.3	74.4	84.1	81.1	90.8	100.0	104.9	116.1	136.6
Other Manufacturing ^{1/}	77.2	80.1	90.1	94.7	87.7	86.8	97.0	100.0	107.4	106.6	109.7

^{1/} Output in real (constant 1975\$) value added for economy, sector and industries.

Source: American Productivity Center

Appendix II, Table 11. Trends in
Labor Input
United States
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	89.8	89.5	92.6	96.2	103.4	93.2	96.2	100.0	105.1	108.6	108.3
Agriculture	102.8	104.6	106.0	104.3	104.6	102.5	100.1	100.0	104.0	105.1	102.8
Nonfarm Nonmanufacturing	85.8	86.8	89.6	92.7	103.5	93.3	96.0	100.0	105.5	109.7	111.3
Mining	74.8	72.8	74.9	77.4	83.2	88.8	94.5	100.0	104.7	116.6	125.0
Construction	89.4	92.2	96.3	101.6	101.0	89.8	92.4	100.0	111.6	118.2	115.8
Transportation & Commun.	96.8	94.5	97.3	100.3	100.0	95.1	96.5	100.0	105.1	109.2	107.9
Electricity, Gas & Water	95.3	94.6	96.7	99.3	100.1	97.7	98.0	100.0	105.5	109.4	112.6
Trade	88.4	89.8	92.2	94.5	94.4	94.3	96.8	100.0	103.6	105.7	105.7
Finance & Insurance	82.7	84.6	87.1	90.6	93.0	94.6	96.4	100.0	107.0	111.8	116.0
Real Estate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Business Services	78.7	79.2	82.4	86.1	123.7	92.2	96.0	100.0	105.6	110.8	115.6
Manufacturing	97.3	93.7	97.8	103.2	101.2	91.4	95.9	100.0	104.4	106.6	101.9
Food & Tobacco	106.9	104.5	103.4	101.8	101.4	98.5	100.5	100.0	100.1	101.3	99.9
Textiles	105.9	105.7	111.0	112.3	103.8	93.2	100.2	100.0	99.3	97.2	93.5
Pulp & Paper	99.9	97.0	99.5	101.9	100.5	90.3	96.7	100.0	101.0	101.4	99.2
Chemicals	97.9	94.5	94.4	97.1	98.5	93.3	96.9	100.0	102.5	104.0	103.4
Primary Metals	104.4	96.5	99.7	109.0	109.9	93.7	96.5	100.0	104.3	106.5	94.3
Fabricated Metals	97.9	92.5	98.2	105.7	103.0	90.6	95.3	100.0	105.4	107.9	100.4
Machinery Exc. Elec.	91.0	82.5	88.6	99.3	103.3	93.9	94.7	100.0	108.4	115.0	114.6
Electrical Machinery	98.3	92.1	96.8	104.9	103.3	88.9	93.5	100.0	106.6	112.3	111.0
Transportation Equipment	94.0	90.3	94.0	102.1	95.3	87.3	94.1	100.0	106.1	107.3	95.9
Other Manufacturing	94.4	93.8	98.9	102.9	99.8	90.0	95.6	100.0	104.3	105.4	100.2

Source: American Productivity Center

Appendix II, Table 12. Trends in
Labor Input
Japan
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	101.0	100.8	100.2	101.6	97.6	95.6	98.7	100.0	101.5	102.7	103.4
Agriculture	145.6	133.1	122.7	113.2	107.9	103.4	101.8	100.0	99.3	93.1	85.7
Nonfarm Nonmanufacturing	88.7	91.3	92.8	95.2	92.4	94.0	97.6	100.0	102.6	105.1	106.7
Mining	161.0	154.5	131.7	120.1	114.4	102.7	96.5	100.0	87.3	88.6	89.4
Construction	84.4	89.6	93.6	99.0	95.1	95.5	99.3	100.0	105.9	107.4	109.6
Transportation & Commun.	93.5	95.1	95.0	99.7	96.4	96.2	100.6	100.0	100.5	103.7	103.5
Electricity, Gas & Water	89.4	90.0	88.9	101.4	95.7	97.7	99.0	100.0	100.6	99.7	98.4
Trade	94.2	94.3	93.7	94.3	91.2	93.5	96.6	100.0	100.6	101.2	102.9
Finance & Insurance	86.6	92.5	92.8	90.3	89.4	93.4	97.9	100.0	99.7	103.0	105.3
Real Estate	64.6	73.4	73.4	85.3	89.5	87.5	89.1	100.0	106.2	108.7	114.8
Business Services	83.6	86.9	90.7	92.5	90.5	92.7	96.7	100.0	104.4	109.4	111.0
Manufacturing	107.9	107.0	106.3	110.1	104.2	95.8	99.7	100.0	99.9	101.6	104.1
Food & Tobacco	111.2	103.7	100.7	102.2	98.0	94.2	100.1	100.0	99.6	99.7	98.1
Textiles	133.4	131.1	121.9	121.8	108.3	98.1	101.0	100.0	102.0	102.6	98.2
Pulp & Paper	114.9	115.9	109.6	112.2	104.2	95.0	101.1	100.0	97.2	97.2	96.0
Chemicals	112.7	109.6	109.6	109.2	108.0	104.4	107.9	100.0	94.4	96.3	99.8
Primary Metals	119.1	117.1	114.7	115.7	112.5	101.3	99.4	100.0	93.9	94.2	101.3
Fabricated Metals	115.7	113.0	111.9	116.3	110.4	98.6	99.4	100.0	100.8	103.6	111.1
Machinery Exc. Elec.	114.5	112.2	109.3	114.6	112.2	96.4	99.1	100.0	96.4	99.2	106.4
Electrical Machinery	106.4	102.7	104.5	111.3	100.3	92.6	99.8	100.0	102.2	105.8	112.9
Transportation Equipment	94.8	97.2	98.3	103.4	100.9	94.6	94.7	100.0	99.8	101.4	108.5
Other Manufacturing	96.7	99.4	102.1	106.7	101.2	94.3	99.9	100.0	101.2	102.8	102.5

Source: American Productivity Center

Appendix II, Table 13. Trends in

Capital Input
United States
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	78.3	80.9	84.0	87.6	90.9	93.6	96.5	100.0	103.9	108.0	111.6
Agriculture	78.2	80.3	82.1	85.3	88.7	92.3	96.1	100.0	104.0	107.6	110.5
Nonfarm Nonmanufacturing	77.6	80.6	84.0	88.0	91.2	93.7	96.6	100.0	103.8	107.8	111.3
Mining	85.0	85.4	85.7	86.8	88.1	91.1	95.0	100.0	104.8	109.4	114.2
Construction	85.5	88.5	93.1	95.8	98.1	97.7	97.7	100.0	103.1	105.7	105.7
Transportation & Commun.	79.7	82.1	83.9	87.5	90.9	94.1	96.9	100.0	103.7	107.9	111.4
Electricity, Gas & Water	68.8	73.5	78.6	83.9	88.8	92.2	95.7	100.0	104.5	109.2	113.2
Trade	74.9	78.0	82.0	86.7	90.5	93.1	96.1	100.0	104.7	109.9	114.7
Finance & Insurance	52.9	57.1	64.2	71.8	78.7	84.5	91.5	100.0	109.1	119.2	130.6
Real Estate	85.6	88.3	91.2	94.6	96.1	97.1	98.3	100.0	101.9	103.8	105.2
Business Services	76.3	79.5	83.3	87.7	90.9	93.5	96.6	100.0	103.7	107.5	110.8
Manufacturing	80.7	82.3	84.3	86.8	90.4	93.2	96.2	100.0	104.1	108.7	112.8
Food & Tobacco	88.6	89.6	90.7	91.8	94.0	95.4	97.5	100.0	102.7	104.9	106.8
Textiles	89.4	91.4	94.0	96.7	98.7	98.7	99.3	100.0	101.3	101.3	101.3
Pulp & Paper	81.1	82.1	83.3	84.9	88.4	91.8	95.9	100.0	104.4	110.4	116.4
Chemicals	77.0	78.5	79.3	80.8	84.8	89.2	94.0	100.0	104.2	109.2	114.0
Primary Metals	88.8	89.8	90.3	91.3	93.8	95.8	97.9	100.0	102.0	103.6	105.5
Fabricated Metals	76.4	78.2	80.3	84.3	88.6	92.1	95.6	100.0	105.2	110.9	115.3
Machinery Exc. Elec.	74.2	76.4	79.0	82.4	87.2	91.1	94.7	100.0	106.5	115.4	123.1
Electrical Machinery	77.8	80.3	82.5	86.8	91.9	93.6	96.2	100.0	105.6	112.0	119.2
Transportation Equipment	77.6	78.4	82.3	85.7	89.9	91.9	94.6	100.0	106.1	113.3	119.9
Other Manufacturing	78.4	80.6	83.9	87.2	91.0	94.0	96.7	100.0	104.0	108.2	111.2

Sources: American Productivity Center

Appendix II, Table 14. Trends in
Capital Input
Japan
(1977=100)

Industry	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Private Domestic Business	53.2	60.2	67.9	75.1	81.8	88.0	93.9	100.0	106.0	113.0	120.5
Agriculture	52.8	59.0	66.5	73.2	79.0	85.1	93.2	100.0	108.2	116.5	124.9
Nonfarm Nonmanufacturing	51.5	57.8	65.4	73.0	80.2	87.0	93.2	100.0	107.1	115.8	124.7
Mining	82.1	88.1	90.5	89.7	91.9	97.1	99.6	100.0	101.8	103.1	105.6
Construction	41.1	49.9	60.4	72.2	80.3	87.6	94.0	100.0	107.9	117.7	127.1
Transportation & Commun.	59.8	66.7	75.2	82.2	88.9	92.9	95.6	100.0	103.6	111.0	117.4
Electricity, Gas & Water	56.5	61.4	68.1	74.6	81.0	86.6	92.9	100.0	108.6	118.1	125.5
Trade	49.1	54.4	61.1	68.9	77.0	85.1	92.6	100.0	106.5	114.4	123.1
Finance & Insurance	61.6	66.1	70.6	73.3	77.2	86.2	93.0	100.0	106.0	108.7	114.7
Real Estate	47.1	56.2	66.1	75.8	81.9	89.2	94.3	100.0	103.5	108.8	115.9
Business Services	40.7	47.6	56.1	65.0	73.6	82.6	90.2	100.0	111.5	125.6	141.6
Manufacturing	54.9	62.8	70.6	77.8	84.3	90.0	94.8	100.0	104.1	109.1	115.1
Food & Tobacco	54.8	62.3	71.2	78.8	84.9	89.9	94.9	100.0	105.2	112.8	119.1
Textiles	71.5	79.3	86.2	92.7	96.3	98.4	101.1	100.0	100.5	100.8	103.5
Pulp & Paper	54.4	61.2	69.1	76.0	82.2	89.9	94.6	100.0	104.8	109.9	116.0
Chemicals	59.3	67.8	75.0	80.4	86.0	93.3	96.6	100.0	103.7	107.1	109.7
Primary Metals	52.8	60.8	69.4	74.9	80.3	86.1	92.3	100.0	102.4	105.2	106.5
Fabricated Metals	46.3	55.0	62.8	72.5	81.6	87.2	93.4	100.0	105.9	114.6	125.2
Machinery Exc. Elec.	56.6	65.5	73.2	79.5	86.7	93.0	97.2	100.0	103.0	107.9	114.3
Electrical Machinery	60.9	66.7	71.6	79.5	86.2	89.5	93.2	100.0	105.8	115.4	129.7
Transportation Equipment	53.0	60.4	68.3	77.7	86.1	91.5	94.9	100.0	105.8	111.3	121.0
Other Manufacturing	51.2	59.1	67.4	75.6	82.9	88.6	94.5	100.0	104.8	110.9	118.6

Source: American Productivity Center

Appendix 3. Supporting Materials

1. Selected Bits of Wisdom on Capital Investment, Innovation, its Dissemination and Embodiment in Improved Technology -- Contributors to Economic Growth.
2. Comparative International Productivity Dynamics: Level of GDP per Hour, Selected years, 1950-82.
3. International Productivity Dynamics: Trends in GDP per hour worked, Selected Periods, 1870-1982.
4. Average Annual Hours Worked per Person and Real GDP per Man Hour in 1970 U.S.; relative prices, selected years 1870-1979.
5. Relative Levels, Real GDP per Employee, based on International Price Weights (U.S. equals 100), 1950-80.
6. Output per hour in Manufacturing, Eleven Countries, 1950-1981.
7. Hourly Compensation of Production Workers in Manufacturing, 26 countries, 1981.
8. Iron and Steel Industry: Absolute Levels of Output per Hour, Hourly Labor Cost, Unit Labor Costs, All Employees, Five Countries, 1964 and 1972.
9. Iron and Steel Industry: Indexes of Relative Levels (U.S. = 100) of Output per Hour, Hourly Labor Costs, Unit Labor Costs, All Employees, U.S., Japan, France and Germany, 1964 and 1972-80.
10. Comparisons of U.S. and Japanese Value-added Labor Productivity by Industry, 1967-1979.
11. Productivity Increases, Four Japanese Industries, 1965-1978.

Appendix III, Table 1.

Capital Investment, Innovation, Dissemination,
Embodiment in Improved Technology -- and
Economic and Productivity Growth

- * "Industrial innovation is at the core of the economic well-being of the United States and is a major contributor to economic growth. Innovation helps combat inflation. It stimulates productivity, employment and the ability of U.S. products to compete both in domestic and world market."
- * Evidence suggests that companies which spend heavily on R&D increase productivity 75 percent more rapidly than do other firms."
- * "...firms which invest heavily in developing technology and carry it forward into commercial products have nine times the employment growth and one-sixth the price increases of firms with relatively low R&D investment."
- * At the time of the civil war a farmer could feed himself and two or three others. But because of advances in farm equipment, better fertilizers and pesticides and seed improvements, the 1980 farmer can feed 65 people at home and abroad."
- * "Partly because of these R&D-induced increases in productivity, the United States was able in 1979 to export agricultural products valued at about \$35 billion, accounting for more than 19 percent of U.S. exports."
- * "Thirty to 40 percent of the economic growth experienced in the United States during the last three decades has been attributed to productivity increases brought about by research and innovation."
- * "Efforts to make computer components smaller have been so successful that the intricacies of 45,000 transistors can be crammed on a tiny chip the size of a contact lens."
- * "The chip functions as a special purpose microcomputer and can perform over a million additions and multiplications per second."
- * "A sophisticated farm implement today can till 60 times more land in one hour than a yoke of ox-drawn plows of yesterday."
- * "In a 10-hour day, 250 people previously could pick by hand the same amount of corn which one modern, self-propelled combine can harvest and shell today."
- * In 1965, when the first communications satellite was launched, it could carry 240 telephone calls at the same time. By the late 1970's, improved satellites could handle 6,250 calls simultaneously. The next generation of satellites will each be capable of transmitting 12,000 to 14,000 telephone calls at once."

-- AND THESE ARE JUST A FEW EXAMPLES --

Basic data: Joint Economic Committee Staff Study, "Research and Innovation: Developing a Dynamic Economy. Dec. 1980.

Source: American Productivity Center

Appendix III, Table 2.

Comparative International Productivity Dynamics
Level of GDP¹ per Hour, Selected Years, 1950-82

(U.S. equals 100, each year)

<u>Country</u>	<u>1950</u>	<u>1960</u>	<u>1973</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>	<u>1982</u>
U.S.	100	100	100	100	100	100	100	100
Japan	14	19	46	52	53	55	56	57
Germany	33	50	71	81	84	85	85	86
France	44	53	76	84	86	89	89	90
U.K.	56	55	64	67	66	66	68	68
Italy	32	39	66	68	70	73	73	73
Canada	78	84	87	86	85	83	82	81
Australia	72	74	73	80	78	79	80	81
Netherlands	53	59	81	90	90	90	90	92
Sweden	55	61	79	79	81	81	79	79
Belgium	50	53	75	85	83	92	92	93
Denmark	43	45	63	64	64	65	66	66
Norway	48	56	69	79	80	82	80	81
Switzerland	52	55	62	61	62	63	64	64
Austria	29	41	62	69	71	74	73	75

¹ Gross domestic product in real (constant dollars) at 1970 prices and exchange rates

Source: American Productivity Center

Basic data: Angus Maddison, revised data through 1979, to appear in "Phases of Capitalist Development," Oxford University Press, spring of 1982. Projections 1979-82 by the APC, using OECD and other-source data for estimation.

Appendix III, Table 3.
International Productivity Dynamics:
Trends in GDP¹ per Hour Worked, Selected Periods 1870-1982

Country	Average Annual Percent of Change					
	1870-1913	1913-1950	1950-1960	1960-1973	1973-1978	1978-1982
United States	2.0	2.6	2.4	2.6	1.5	0.7
Japan	1.8	1.3	5.7	9.8	3.9	3.3
Germany	1.9	1.1	6.9	5.4	4.3	2.2
France	1.8	2.0	4.5	5.6	3.5	2.4
U.K.	1.2	1.6	2.2	3.8	2.5	1.2
Italy	1.2	1.8	4.4	6.9	2.1	2.3
Canada	2.0	2.3	3.1	3.0	1.3	-0.2
Australia	0.6	1.6	2.8	2.5	3.3	0.9
Netherlands	1.2	1.7	3.4	5.3	3.7	1.1
Sweden	2.3	2.8	3.5	4.7	1.7	0.6
Belgium	1.2	1.4	3.2	5.4	4.2	2.8
Denmark	1.9	1.6	3.0	4.3	1.7	1.8
Norway	1.7	2.5	4.1	4.3	4.0	1.3
Switzerland	1.4	2.1	3.0	3.6	1.2	1.9
Austria	1.7	0.9	5.9	6.0	3.7	2.6

¹ Gross domestic product in real (constant dollars) at 1970 prices and exchange rates

Source: American Productivity Center

Basic data: Angus Maddison, revised data through 1979, to appear in "Phases of Capitalist Development," Oxford University Press, spring of 1982. Projections 1979-82 by the APC, using OECD and other-source data for estimation.

Appendix III, Table 4
Average Annual Hours Worked per Person

	1870	1880	1890	1900	1913	1929	1938	1950	1960	1970	1973	1978	1979
Australia	2945	2852	2770	2688	2588	2139	2110	1838	1767	1755	1708	1579	1619
Austria	2935	2842	2760	2679	2580	2281	2312	1976	1951	1848	1778	1650	1660
Belgium	2964	2871	2789	2707	2605	2272	2267	2283	2174	1986	1872	1726	1747
Canada	2964	2871	2789	2707	2605	2399	2240	1967	1877	1805	1788	1734	1730
Denmark	2945	2852	2770	2688	2588	2279	2267	2283	2127	1882	1742	1695	1721
Finland	2945	2852	2770	2688	2588	2123	2183	2035	2041	1704	1707	1684	1770
France	2945	2852	2770	2688	2588	2297	1848	1989	1983	1888	1830	1727	1727
Germany	2941	2848	2765	2684	2584	2284	2316	2316	2083	1907	1827	1733	1719
Italy	2886	2795	2714	2634	2536	2228	1927	1997	2059	1768	1612	1417 ^a	1399
Japan	2945	2852	2770	2688	2588	2364	2391	2272	2432	2252	2197	2111	2129
Netherlands	2964	2871	2789	2707	2605	2260	2244	2208	2177	1910	1825	1671	1679
Norway	2945	2852	2770	2688	2588	2283	2128	2101	1997	1789	1721	1577	1559
Sweden	2945	2852	2770	2688	2588	2283	2204	1951	1823	1660	1571	1463	1451
Switzerland	2984	2890	2807	2725	2624	2340	2257	2144	2065	1962	1930	1889	1877
U.K.	2984	2890	2807	2725	2624	2286	2267	1958	1913	1735	1720	1628	1617
U.S.	2964	2871	2789	2707	2605	2342	2062	1867	1795	1707	1696	1620	1607

Table C-10

Productivity: GDP Per Man Hour in 1970 US Relative Prices (\$) 1870-1979

	1870	1880	1890	1900	1913	1929	1938	1950	1960	1970	1973	1978	1979
Australia	1.30	1.56	1.62	1.49	1.70	2.16	2.34	3.05	4.02	5.02	5.56	6.55	6.48
Austria	0.43	0.50	0.61	0.74	0.90	1.01	n.a.	1.25	2.21	3.94	4.72	5.66	5.89
Belgium	0.74	0.89	1.02	1.12	1.26	1.68	1.84	2.11	2.89	4.71	5.70	6.99	7.31
Canada	0.61	0.76	0.86	1.02	1.45	1.76	1.75	3.33	4.54	5.96	6.64	7.08	7.03
Denmark	0.44	0.51	0.62	0.75	1.00	1.51	1.57	1.82	2.45	4.00	4.78	5.22	5.27
Finland	0.32	n.a.	(0.44)	n.a.	0.71	0.97	1.15	1.48	2.20	4.16	4.76	5.34	5.26
France	0.42	0.53	0.58	0.71	0.90	1.31	1.69	1.85	2.87	4.92	5.80	6.89	7.11
Germany	0.43	0.50	0.62	0.79	0.95	1.19	1.47	1.40	2.72	4.62	5.40	6.65	6.93
Italy	0.44	0.45	0.47	0.53	0.72	0.98	1.28	1.37	2.10	4.10	5.03	5.57	5.83
Japan	0.17	n.a.	(0.24)	n.a.	0.37	0.64	0.87	0.59	1.03	2.79	3.49	4.22	4.39
Netherlands	0.74	n.a.	(0.97)	1.07	1.23	1.82	1.80	2.27	3.17	5.19	6.17	7.41	7.42
Norway	0.40	0.46	0.56	0.63	0.82	1.28	1.62	2.03	3.04	4.78	5.28	6.43	6.65
Sweden	0.31	0.37	0.45	0.59	0.83	1.22	1.55	2.34	3.30	5.33	5.99	6.51	6.71
Switzerland	0.55	n.a.	0.74	n.a.	1.01	1.68	1.84	2.21	2.98	4.31	4.73	5.02	5.12
U.K.	0.80	0.94	1.06	1.20	1.35	1.70	1.84	2.40	2.99	4.27	4.84	5.47	5.48
U.S.	0.70	0.88	1.06	1.29	1.67	2.45	2.62	4.25	5.41	6.96	7.60	8.19	8.28

Appendix III, Table 5

RELATIVE LEVELS: PURCHASING-POWER-PARITY EXCHANGE RATES

REAL GROSS DOMESTIC PRODUCT, REAL GDP PER CAPITA, AND REAL GDP PER EMPLOYED PERSON(1)
OUTPUT BASED ON INTERNATIONAL PRICE WEIGHTS
(UNITED STATES = 100)

YEAR	CANADA	JAPAN	BELGIUM	FRANCE	GERMANY (2)	ITALY	NETHER- LANDS	UNITED KINGDOM
GROSS DOMESTIC PRODUCT PER EMPLOYED PERSON(3)								
1950	84.4	16.8	55.7	42.2	37.2	27.7	58.3	53.5
1955	87.6	20.3	56.3	45.2	44.8	30.6	61.0	52.2
1960	89.7	25.8	60.0	53.5	56.1	38.0	66.3	53.9
1965	88.6	33.6	62.8	59.7	59.6	44.1	66.9	52.0
1966	87.0	35.3	62.7	60.3	61.8	46.2	66.2	51.4
1967	87.2	38.2	65.2	62.8	61.0	48.9	69.7	53.1
1968	88.3	41.2	66.4	63.4	63.3	51.0	71.5	54.3
1969	89.8	45.7	69.4	66.6	67.0	54.4	74.6	54.8
1970	91.9	50.0	73.1	70.7	70.7	57.6	79.3	56.8
1971	93.4	50.6	73.6	72.6	71.0	57.0	80.6	57.0
1972	93.7	53.6	76.2	75.0	72.2	58.4	82.6	55.8
1973	94.0	55.8	78.7	76.9	74.2	60.6	86.2	57.0
1974	96.0	56.9	83.2	80.9	78.0	63.5	91.5	57.7
1975	95.1	58.3	82.6	81.6	79.0	60.8	90.9	57.5
1976	96.7	59.6	85.9	83.6	82.3	62.6	93.9	58.8
1977	95.6	60.8	85.5	84.0	83.4	62.4	94.2	58.2
1978	95.9	62.9	87.9	86.6	85.2	63.6	96.0	59.8
1979	95.2	65.3	88.9	89.8	87.8	65.8	96.9	60.5
1980	93.3	68.0	91.9	91.6	89.4	68.1	96.5	61.3
1981	92.9	70.0	91.7	92.1	89.4	67.3	95.1	62.0

(1) DATA FOR THE LATEST YEAR ARE BASED ON PRELIMINARY ESTIMATES.

(2) EXCLUDING THE SAAR AND WEST BERLIN IN 1950 AND 1955.

(3) EMPLOYMENT FIGURES FOR THE NETHERLANDS ARE DUTCH ESTIMATES OF WORK-YEARS OF EMPLOYED PERSONS. FOR 1981, THE DUTCH ESTIMATE THAT THERE WERE 5.06 MILLION EMPLOYED PERSONS--5 PERCENT GREATER THAN THE WORK-YEAR ESTIMATE.

Data Source: U.S. Bureau of Labor Statistics.

Appendix III, Table 6

OUTPUT PER HOUR IN MANUFACTURING, ELEVEN COUNTRIES, 1950-1981

(INDEXES: 1977=100)

YEAR (1)	UNITED STATES	CANADA	JAPAN	BEL- GIUM	DEN- MARK	FRANCE	GERMANY	ITALY	NETHER- LANDS	SWEDEN	UNITED KINGDOM
1950	49.5	34.7	9.0		24.1	25.4	22.0	20.9	20.0	30.7	44.8
1951	51.2	36.1	11.2		26.4	26.7	22.7	23.3	20.7	31.6	44.9
1952	52.1	37.0	11.8		26.2	27.6	24.8	24.3	21.2	31.5	45.2
1953	53.0	38.3	13.4		26.5	29.1	26.6	25.5	22.9	33.2	45.2
1954	51.8	40.0	14.3		27.7	29.9	27.7	26.8	23.7	33.2	46.7
1955	54.5	42.6	15.1		28.4	31.4	29.5	29.2	25.0	35.6	48.3
1956	56.1	44.4	16.0		29.2	33.4	30.3	30.8	26.5	35.7	48.3
1957	57.2	44.7	17.5		30.3	34.0	32.9	31.4	27.5	37.5	49.5
1958	57.0	46.2	16.4		31.3	35.3	34.6	31.9	28.1	39.2	50.5
1959	59.7	48.7	19.1		33.4	37.8	37.4	34.4	30.2	41.6	52.5
1960	60.1	50.4	22.0	31.8	34.5	39.5	40.0	36.5	31.7	43.6	55.6
1961	61.7	53.1	24.9	32.4	36.5	41.6	42.1	39.5	33.4	45.0	56.1
1962	64.4	55.9	26.0	34.4	38.4	43.6	44.7	43.7	34.5	43.3	57.9
1963	69.0	56.0	28.1	35.8	39.6	46.1	46.8	45.9	35.5	51.1	60.6
1964	72.4	60.6	31.0	38.0	42.8	48.5	50.3	47.6	35.9	55.4	64.9
1965	74.6	62.9	33.1	39.8	44.9	51.3	53.5	52.9	41.3	59.4	67.0
1966	75.4	65.1	36.5	42.5	47.2	54.9	55.4	56.4	44.0	61.8	69.4
1967	75.4	67.1	41.9	45.3	51.4	57.9	59.0	59.7	47.1	66.9	72.7
1968	78.1	71.7	47.1	49.3	56.0	64.5	63.0	64.5	52.8	73.1	76.0
1969	79.4	75.9	54.5	53.6	58.2	66.8	66.9	69.4	57.7	78.6	79.9
1970	79.2	77.0	61.4	58.6	61.9	70.2	68.5	72.7	63.0	82.0	80.5
1971	84.1	82.5	55.3	62.0	65.8	73.9	71.6	74.9	67.3	85.2	83.7
1972	85.3	86.2	72.7	69.2	71.2	78.2	75.9	81.1	72.6	90.8	90.3
1973	93.1	91.6	50.2	76.4	78.5	82.5	80.4	90.9	80.1	97.5	95.8
1974	90.9	93.6	82.1	80.7	81.1	85.3	85.2	95.3	86.7	100.9	96.5
1975	93.5	91.2	85.3	85.0	89.5	88.0	89.3	91.1	85.2	100.3	94.4
1976	97.7	96.1	93.3	93.7	96.4	95.2	95.0	96.9	95.1	101.6	98.4
1977	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1978	100.9	101.6	107.9	106.7	104.4	125.3	103.8	103.0	105.7	104.3	103.2
1979	102.0	103.3	117.4	112.8	106.9	111.0	106.9	110.5	111.3	112.7	106.7
1980	101.7	121.3	125.4	117.6	106.7	111.7	110.1	116.9	112.5	113.4	107.2
1981	104.0	101.9	129.1		115.1	114.3	113.0	119.2		112.8	113.4

(1) PRELIMINARY ESTIMATES FOR LATEST YEAR.

NOTE: THE DATA RELATE TO ALL EMPLOYED PERSONS (WAGE AND SALARY EARNERS, THE SELF-EMPLOYED, AND UNPAID FAMILY WORKERS) IN THE UNITED STATES AND CANADA, AND ALL EMPLOYEES (WAGE AND SALARY EARNERS) IN THE OTHER COUNTRIES.

SOURCE: U.S. DEPARTMENT OF LABOR, BUREAU OF LABOR STATISTICS

Appendix III, Table 7

HOURLY COMPENSATION OF PRODUCTION WORKERS IN MANUFACTURING

TEN COUNTRIES, 1981

(PROVISIONAL ESTIMATES)

COUNTRY	EXCHANGE RATE		AVERAGE HOURLY EARNINGS IN NATIONAL CURRENCY	RATIO OF ADDITIONAL COMPEN- SATION TO HOURLY EARNINGS	HOURLY COMPENSATION		
	NATIONAL CURRENCY UNIT	NATIONAL CURRENCY UNITS PER U.S. DOLLAR			NATIONAL CURRENCY	U.S. DOLLARS	INDEX U.S.=100
UNITED STATES	DOLLAR	-----	7.98	38.6	11.06	11.06	100
CANADA	DOLLAR	1.199	9.13	29.5	11.82	9.86	89
JAPAN	YEN	220.1	1,176	(1) 16.7	1,372	6.23	56
BELGIUM	FRANC	37.03	240.0	71.8	412.3	11.13	101
FRANCE	FRANC	5.409	25.22	77.5	44.77	8.28	75
GERMANY	MARK	2.254	13.89	69.9	23.60	10.47	95
ITALY	LIRA	1,131	4,602	86.6	8,587	7.59	69
NETHERLANDS	GUILDER	2.488	14.39	(1) 77.2	25.50	10.25	93
SWEDEN	KRONA	5.035	36.74	62.8	59.81	11.88	107
UNITED KINGDOM	POUND	.4940	2.73	34.4	3.67	7.43	67

(1) ALL EMPLOYEES.

PREPARED BY: U.S. DEPARTMENT OF LABOR, BUREAU OF LABOR STATISTICS, OFFICE OF PRODUCTIVITY AND TECHNOLOGY, APRIL 1982.

Appendix III, Table 8.

IRON AND STEEL INDUSTRY: OUTPUT PER HOUR, HOURLY LABOR COST, UNIT LABOR COST,
ALL EMPLOYEES, FIVE COUNTRIES, 1964 AND 1972

C. ABSOLUTE LEVELS

YEAR	UNITED STATES	JAPAN		FRANCE		GERMANY		UNITED KINGDOM	
		MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
OUTPUT <u>1/</u> IN SHORT TONS PER 1,000 HOURS									
1964	81.18	35.98	41.20	37.98	40.18	42.78	46.75	38.52	40.17
1972	94.29	77.97	91.98	59.03	63.75	72.12	76.89	49.94	52.24
TOTAL HOURS PER SHORT TON <u>1/</u>									
1964	12.32	24.27	27.79	24.89	26.33	21.39	23.38	24.90	25.96
1972	10.61	10.87	12.83	15.69	16.94	13.01	13.86	19.14	20.03
HOURLY LABOR COST IN U.S. DOLLARS <u>2/</u>									
1964	4.63	0.74	0.75	1.57	1.60	1.63	1.63	1.33	1.37
1972	7.44	2.44	2.51	3.31	3.31	4.29	4.29	2.46	2.53
UNIT LABOR COST IN U.S. DOLLARS <u>2/</u> PER SHORT TON <u>1/</u>									
1964	57.00	18.10	20.71	39.43	41.79	34.95	38.20	33.27	35.44
1972	78.94	26.58	32.16	51.91	56.05	55.75	59.44	47.35	50.55
OUTPUT <u>1/</u> IN 1000'S OF SHORT TONS									
1964	92,803.0	32,743.4	36,295.4	17,287.2	18,287.4	31,499.8	34,424.2	21,524.5	22,218.0
1972	95,016.0	83,894.1	92,674.9	22,094.0	23,859.2	44,676.1	47,629.8	20,329.8	21,076.3
HOURS WORKED IN 1000'S									
1964	1,143,197	856,916	935,461	455,187	455,187	736,330	736,330	548,462	563,510
1972	1,007,647	974,952	1,112,006	374,277	374,277	619,427	619,427	399,829	410,799

Data Source: U.S. Bureau of Labor Statistics

Appendix III, Table 9

IRON AND STEEL INDUSTRY: OUTPUT PER HOUR, HOURLY LABOR COST, UNIT LABOR COST,
ALL EMPLOYEES, FIVE COUNTRIES, 1964 AND 1972-80

A. RELATIVE LEVELS (UNITED STATES=100)

YEAR	OUTPUT PER HOUR		HOURLY LABOR COST 1/		UNIT LABOR COST 1/	
	MINI-MUM	MAXI-MUM	MINI-MUM	MAXI-MUM	MINI-MUM	MAXI-MUM
UNITED STATES						
EACH YEAR	100	100	100	100	100	100
JAPAN						
1964	44	51	16	16	32	36
1972	83	98	33	34	34	41
1973	98	116	41	43	36	43
1974	98	116	44	46	39	47
1975	96	115	44	46	39	47
1976	102	124	44	45	37	43
1977	108	130	50	52	39	47
1978	106	129	61	63	49	58
1979	119	145	55	57	39	46
1980	128	155	52	53	34	41
FRANCE						
1964	47	49	34	35	69	73
1972	63	68	44	44	66	71
1973	64	69	54	54	79	86
1974	65	70	55	55	79	85
1975	60	64	66	66	102	110
1976	63	68	63	63	92	100
1977	69	74	65	65	88	95
1978	71	77	71	71	93	100
1979	79	86	76	76	88	96
1980	86	93	78	78	84	91
GERMANY						
1964	53	58	35	35	61	67
1972	76	82	58	58	71	75
1973	82	87	73	73	84	90
1974	85	91	77	77	84	90
1975	81	87	75	75	87	92
1976	84	90	73	73	81	87
1977	87	93	79	79	86	91
1978	89	94	88	88	93	99
1979	99	105	93	93	88	94
1980	102	109	91	91	83	89

Data Source: U.S. Bureau of Labor Statistics

Appendix III, Table 10.
Comparison of U.S. and Japanese Value-added Labour
Productivity by Industry

(U.S. figures for each year = 100)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1979
All manufacturing (excluding tobacco and weapons)	39	43	51	57	57	60	69	71	73	73	83
Steel	62	63	74	88	86	97	130	144	165	185	208
Non-ferrous metals	42	43	61	78	54	56	66	76	44	63	82
Metal products	36	37	44	52	52	60	67	62	69	75	86
General machinery	42	46	55	60	66	61	63	65	77	82	111
Electrical machinery	44	50	56	64	65	70	82	89	91	99	119
Transport machinery	42	47	55	67	64	71	85	84	95	110	124
Automobiles (includes two-wheel vehicles)	38	40	48	63	55	61	72	83	82	86	100
Transport machinery excluding automobiles	35	38	49	54	61	73	91	86	95	121	-
Precision machinery	26	28	34	38	38	41	55	75	74	73	134

- Note:**
1. Figures above are Japanese value-added labour productivity figures calculated using the corresponding U.S. figure as 100.
 2. Value-added per labour hour for 1967-1976 for the two countries are calculated at 1970 prices and the countries compared using the 1979 interbank exchange rate of \$1 = ¥219.47 for conversion.
 3. 1979 figures have been estimated from 1976 figures applying the differential in the two countries' 1976-1979 material labour productivity indices.

Source: Koji Matsumoto, "Organizing for Higher Productivity: An Analysis of Japanese Systems and Practices", Asian Productivity Organization (Tokoyo) 1982.

Basic data: MITI and Japan Productivity Organization Center cited in MITI White Paper.

JAPANESE PRODUCTIVITY TODAY

Appendix III, Table 11.

Productivity Increases, Four Japanese Industries

A. Steel: Direct labour time required per ton of product*

	1965	1970	1975	1978	$\frac{1978}{1965} \%$
Blast furnace pig iron	0.35	0.16	0.13	0.12	34
Conversion furnace steel	0.48	0.34	0.38	0.35	73
Electric furnace steel	3.41	2.19	1.67	1.02	30

B. Automobiles: Direct labour time required per vehicle*

	1965	1970	1975	1978	$\frac{1978}{1965} \%$
Compact passenger car	60.8	37.1	25.9	20.4	34
Small truck	59.4	35.4	25.6	21.1	36
Standard-size gasoline-engine truck	65.6	60.3	28.6	25.5	39
Standard-size diesel-engine truck	73.5	65.2	35.9	29.8	41

C. Spinning: Labour time required per 20-count bale

	1965	1970	1975	1978	$\frac{1978}{1965} \%$
Direct labour time	25.9	19.3	16.5	12.7	49
Indirect labour time	0.9	0.8	0.6	0.5	56
Total	26.8	20.1	17.1	13.2	49

D. Cement: Labour time required per ton

	1965	1970	1975	1978	$\frac{1978}{1965} \%$
Direct labour time	0.40	0.23	0.18	0.11	28
Indirect labour time	0.63	0.28	0.20	0.13	21
Total	1.03	0.51	0.38	0.25	24

- * Direct labour time is the labour time required directly for production. In the steel industry, for example, this is the labour time for pig iron production, steel production, and rolling; and the time for such intermediate or support processes as transport of raw materials, analysis and inspection, maintenance and repairs, and power have been classed as indirect labour time.

Basic data: Statistical Survey of Labour Productivity, Ministry of Labour.

Source: Asian Productivity Organization, Op. cit.

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ERRATA

Comparative Productivity Dynamics

Published November 1982

Please note the following corrections to Comparative Productivity Dynamics: Japan and the United States.

Page 3, Table 1

<u>Segment of the economy</u>	<u>Estimated levels of real output per hour</u>	
	<u>1973</u>	<u>1980</u>
Private Business		
U.S.	\$9.06	\$9.27
Japan	<u>4.64</u>	<u>6.01</u>

Page 14, final paragraph

As noted previously, labor productivity in Japan grew at an average annual rate of 5.3 percent per year in the 1970s, compared to the U.S. pace of only 1.2 percent. (Table 2.)

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